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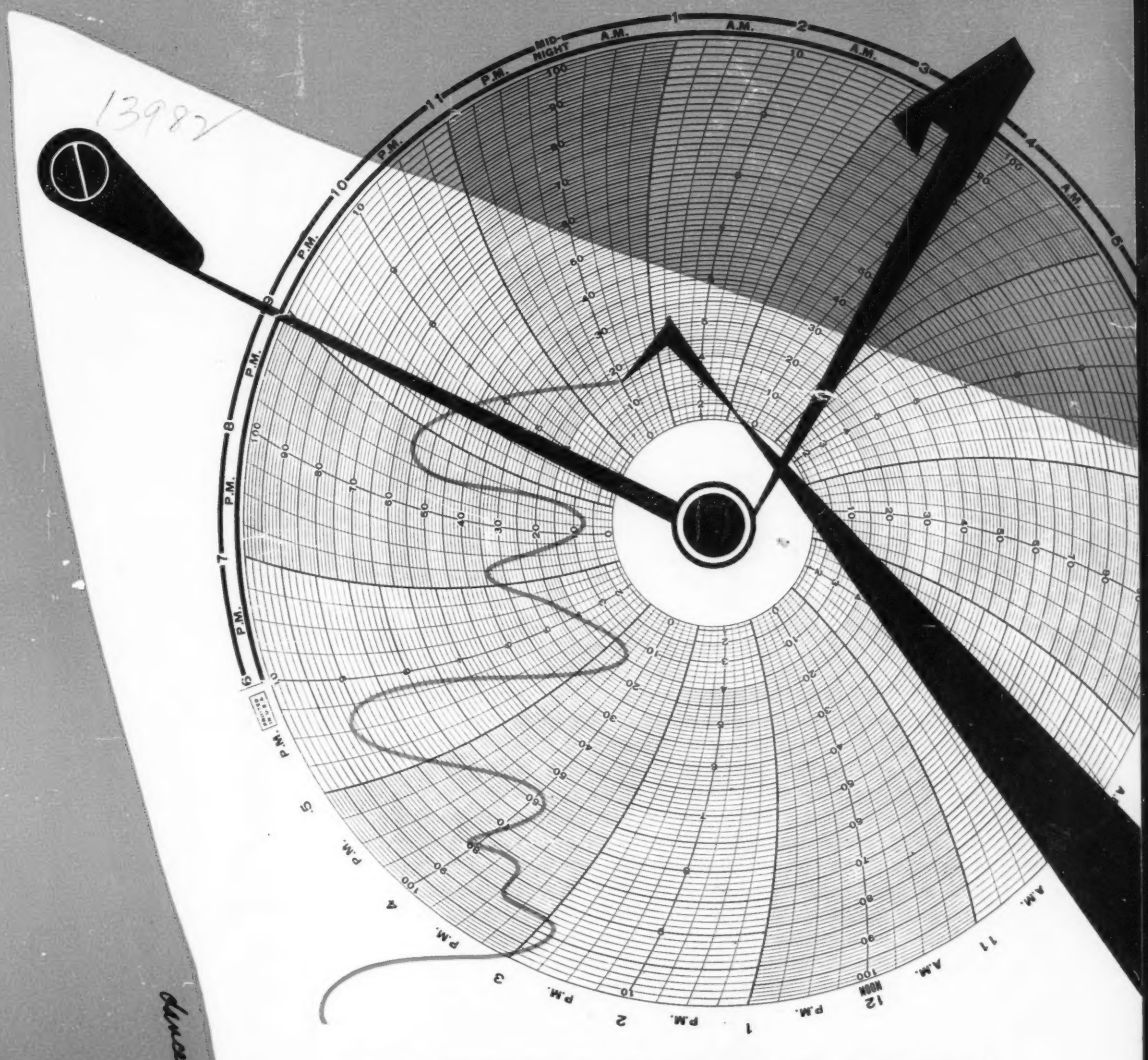
Design Engineering

FIVE DOLLARS A YEAR



THE DESIGN OF RECORDING CHARTS

How Man has improved on Nature's sapphire

Have you considered silver brazing?

January 1957

PUBLISHED BY MACLEAN-HUNTER PUBLISHING COMPANY, LIMITED, TORONTO, CANADA

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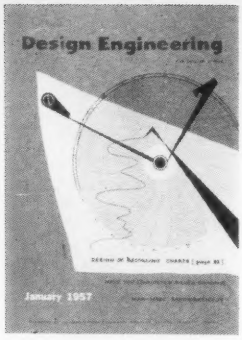

Design Engineering

VOL. 3 JANUARY 1957 NO. 1

This month's cover

Once again Don Dancer has given us a striking cover for the magazine. Perhaps more representational and less abstract than his usual style, the work is based on the recording chart article in the issue. Focal point is, of course, a chart face. The bold outline of the tracing pen linkage lends an abstract touch.

Design Engineering

MEMBER

CCAB

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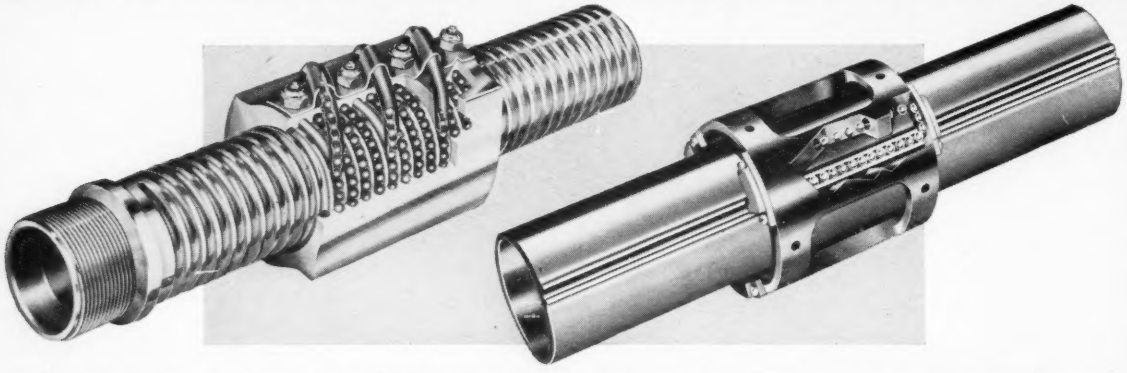
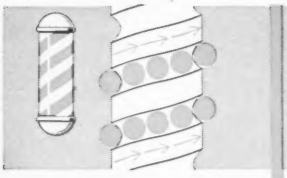
These MODERN Recirculating Ball Units can help you...

SOLVE ACTUATION and TORQUE PROBLEMS

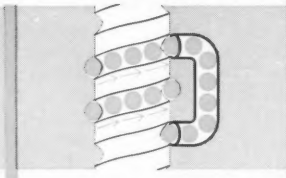


Saginaw b/b Screws guaranteed 90% efficient —offer 6 major advantages for designers

Available in custom machined and commercial rolled thread types—have been built from 1½ inches to 39½ feet long—⅜ to 10 inches diameter.



Nut *glides* on steel balls. Like stripes on a barber pole, the balls travel toward end of nut through spiral "tunnel" formed by concave threads in both screw and mating nut.



At end of trip, one or more tubular guides lead balls diagonally back across outside of nut to starting point, forming closed circuit through which balls recirculate.

1 VITAL POWER SAVINGS. With guaranteed efficiency of 90%, Saginaw b/b Screws are up to 5 times as efficient as Acme screws, require only ⅕ as much torque. This permits much smaller motors with far less drain on the electrical system. Circuitry is greatly simplified.

2 SPACE/WEIGHT REDUCTION. Saginaw b/b Screws permit use of smaller motors and gear boxes; eliminate pumps, accumulators and piping required by hydraulics. In addition, Saginaw b/b Screws themselves are smaller and lighter. Units have been engineered from 1½ in. to 39½ ft. in length.

3 PRECISE POSITIONING. Machine-ground Saginaw b/b Screws offer a great advantage over hydraulics or pneumatics because a component can be positioned at a predetermined point with precision. Tolerances on position are held within .0006 in./ft. of travel.

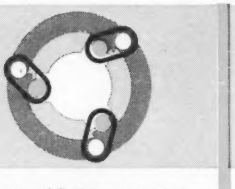
4 TEMPERATURE TOLERANCE. Normal operating range is from −75° to +275° F., but assemblies have been designed in selected materials which function efficiently as high as +900° F. These units are practical where hydraulic fluids have lost efficiency or reached their flash point.

5 LUBRICATION LATITUDE. Even if lubrication fails or cannot originally be provided because of extreme temperatures or other problems, Saginaw b/b Screws will still operate with remarkable efficiency. Saginaw units have been designed, built and qualified for operation without any lubrication.

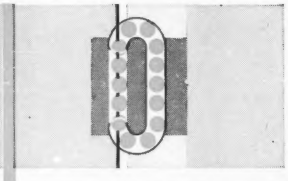
6 FAIL-SAFE PERFORMANCE. Far less vulnerable than hydraulics. In addition, Saginaw offers three significant advantages over other makes: (1) Gothic arch grooves eliminate dirt sensitivity, increase ball life; (2) yoke deflectors and (3) multiple circuits provide added assurance against operating failure.

Saginaw b/b Splines average 40 times lower friction coefficient than sliding splines

Transmit or restrain high torque loads far more efficiently—have been built from 3 inches to 10 feet long—⅜ inch to 6 inches in diameter.



The *Saginaw b/b Spline* radically increases the efficiency of transmitting or restraining high torque loads. Instead of *sliding* against each other, surfaces *glide* on rolling balls.



The steel balls recirculate in closed circuits formed by mating longitudinal raceways spaced around the circumference of inner and outer splines. Guides return balls.

This revolutionary new kind of spline utilizes the same basic principle pioneered by Saginaw in the ball/bearing screw.

It permits new engineering designs never before practical—literally lets you achieve the "impossible"! In any application where column length must change under torque load, the Saginaw b/b Spline offers greatly decreased friction, less wear, longer life, more dependable operation. It can be fitted with integral gears, clutch dogs, bearing and sprocket seats or a wide choice of other attachments for use with electric, hydraulic or pneumatic units. To convert push-pull to rotary motion, helical types are available with very high leads, ranging from 20:1 to 100:1.

SEND TODAY FOR THIS FREE 1957 ENGINEERING DATA BOOK...

Saginaw Steering Gear Division
General Motors Corporation
b/b Screw and Spline Operation
Dept. 4W, Saginaw, Michigan

Please send new engineering data book on Saginaw b/b Screws and Splines to:

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Saginaw ball bearing Screws and Splines

SAGINAW STEERING GEAR DIVISION OF GENERAL MOTORS

WORLD'S LARGEST PRODUCER OF BALL BEARING SCREWS AND SPLINES

Design Engineering

Inside

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In our next issue

Feature article of the February issue will be devoted to fasteners. Complete coverage of the vast fastener field is impossible but an outline of basic types and some of their developments will be given. Also slated for publication in February are articles on anodized aluminum, thermistors and analog computers.

Merrill

Lloyd P. Merrill was born and brought up at Watertown in New York State and graduated from Cornell University in 1938 with an M.E. degree. The following year he received his M.M.E. and, in 1945, his N.Y. State professional engineers licence.

Since leaving Cornell, Merrill has worked for Taylor Instrument Companies in the production control and engineering testing departments. He is now a project engineer in the engineering design and development department. His contacts with charts and chart paper (article in this issue) began in the engineering testing laboratory at Taylor.

The man at the right is no newcomer to Design Engineering, having been a contributor before. He is **F. L. Neuman, B.S., P.Eng.,** general manager of the special products department at Linde Air Products Co., Toronto. Neuman is a graduate in metallurgical engineering from Michigan College of Mining and Technology and has held various positions with the Linde organization in development, production and sales. Prior to his recent appointment he was general superintendent of Linde's sixteen plants. Neuman is a member of the Association of Professional Engineers of Ontario. He lists golf, sailing, photography and gardening as hobbies.

Neuman

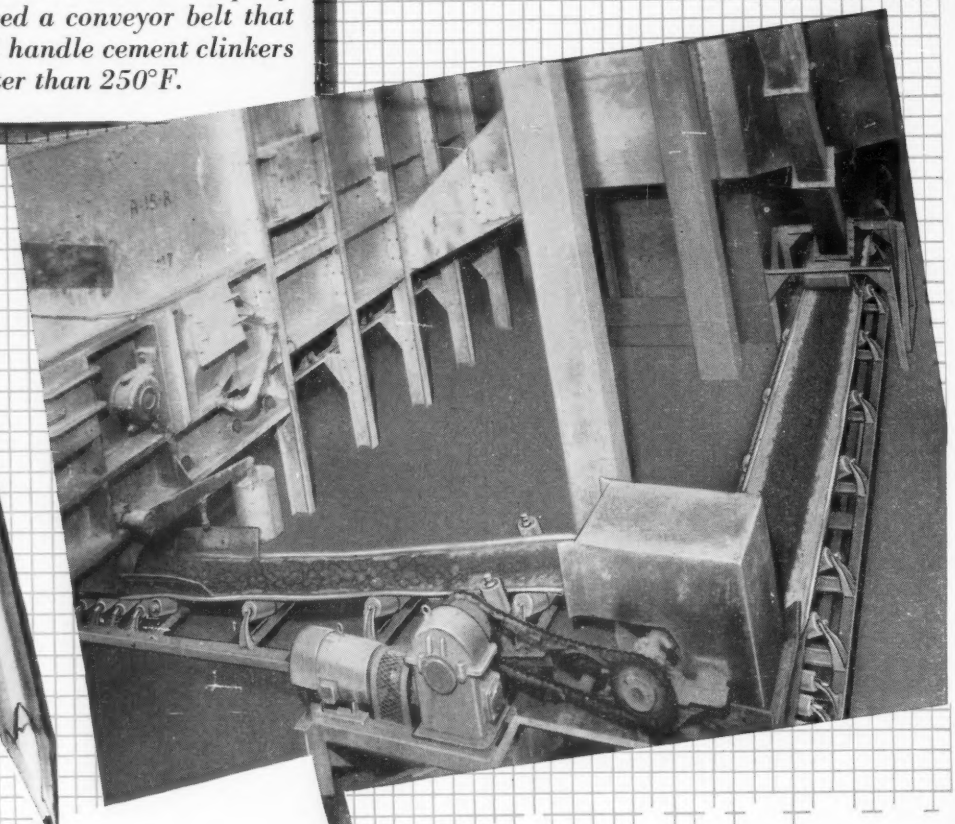
Setapen

Author **A. M. Setapen** (of our silver brazing article) studied at Rensselaer Polytechnic Institute, where he got his Ch.E. and M.S. and did additional study at the Carnegie Institute of Technology. For three years he conducted research work on industrial uses of silver and silver alloys at the Bureau of Standards, Washington, D.C. He is manager, engineering division, at Handy and Harman, a company he has been with for sixteen years.

Setapen is a member of several technical societies including the American Welding Society, and the American Society for Metals. His exercise is usually in the form of golf or tennis.

Problem

The Canada Cement Company required a conveyor belt that would handle cement clinkers at better than 250°F.



Solution

*Dunlop used *Polysar Butyl in its "Superhet" conveyor belting to achieve a 300% increase in serviceability.*

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NOTHING PERFORMS LIKE RUBBER — *The best buy for your money*

Reports

News in brief from the world's producers

Carbide Chemicals expands

A further expansion in production capacity for polyethylene resin and ethylene glycol was announced recently by **Carbide Chemicals Co.,** division of Union Carbide Canada Ltd. Construction of this multi-million-dollar addition to the company's Montreal east plant will begin as soon as possible and will double the 1955 planned polyethylene production capacity.

ASM meeting

Some speakers have the art of making a lecture interesting and **Dr. L. M. Pidgeon,** head of Metallurgical Engineering at the University of Toronto, is most certainly one of them.

This was well shown last month in his instructive and amusing talk to the American Society of Metals (Ontario Chapter) on future trends in extractive metallurgy.

Translating made easy

Russian scientists have perfected an automatic translating machine which operates by electronics. It was demonstrated at a meeting of the Sciences Academy on Scientific Problems of Industrial Automation.

A text in English was teletyped from the conference hall to a nearby institute where it was translated into Russian by the machine and flashed back to the delegates.

Solar engines

Solar engines, used to convert the energy of the sun into heat and mechanical power, have immediate practical application in the arid areas of the world and may be economically feasible everywhere within the next 50 years.

So said **Peter Courvoisier,** research physicist of the solar observatory at Davos, Switzerland, in a talk delivered at the annual meeting of the **American Society of Mechanical Engineers.**

The recent ban on Sunday driving in Switzerland, brought about by the Middle East crisis, serves to show what may happen on the continent in the next half-century when oil reserves have been depleted. For the present, however, solar engines seem to be the most feasible in arid areas where other sources of heat and energy are expensive or impossible to obtain.

CRTPB meets

The 12th annual meeting of the **Canadian Radio Technical Planning Board** will take place in the Terrace Room of the Chateau Laurier Hotel, Ottawa, on Thursday January 17 at 10 a.m.

New type train

A radical new design has been proposed in the Argentine that would eliminate the traditional flanged-wheel-on-steel-rail operation. The new train, designed for extremely high speeds, would be operated on rails three feet above the ground. Pneumatic tires would ride directly on top of a broad flanged rail and guidance would be achieved by small wheels contacting a sloping underside of the rail on which the supporting wheels ride.

Engineering and science popular

Engineering and science are the two most popular courses being studied today by winners of scholarships being sponsored by **Union Carbide Canada Ltd.**

Started three years ago, these scholarships are now held by 49 young men and women studying at 19 universities across Canada. Of these students, 17 are working toward their degrees in engineering, 17 are in science, and the others are enrolled in such varied subjects as architecture, economics, history, home economics, nuclear energy and political science.

Speed of artillery shells

The very accurate measurement of the speed of artillery shells will be possible to a degree never before achieved when the **Canadian Research and Development Establishment** takes delivery of a light screen system for projectile velocity measurement from **C.D.C.**

Shells will be fired through a series of sixteen stations, each consisting of a screen of light only 1/10 in. thick. As the shell passes through the light screen, minute changes in the amount of light crossing the screen are measured with photocell amplifiers. In the system the minimum time taken for a shell to travel from one station to the next one, 50 feet away, is measured with an accuracy of less than one millionth of a second.

The over-all accuracy of the velocity measurement is 0.02%.

Ex-Cell-O expands

Ex-Cell-O Corporation of Canada has just opened a new 13,000-sq-ft engineering and administrative building at their head office and plant in London, Ontario and now announces that work has already been started on a new 27,000-sq-ft plant extension.

1957 Nuclear Congress

Peacetime uses of atomic energy will be the topic of the 1957 Nuclear Congress, scheduled for March 11-15 at Philadelphia's Convention Hall, under the co-ordination of **Engineers Joint Council.** The session will bring together leaders in science, engineering, industry, government, education, agriculture and other fields.

Standards engineers

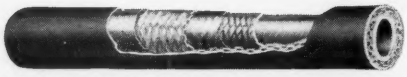
The second Canadian section of the **Standards Engineers Society** has been established at Hamilton by twenty-two engineers representing electrical, electronic, aircraft and allied industries as well as the Hydro Electric Power Commission and the Canadian Standards Association.

Newly elected officers are M. J. McKerrow, Gordon Wells, W. T. Winslow and E. G. Price. (See picture on this page)

All smiles in the newly formed section of the Standards Engineers Society.

Specify These Aeroquip Hose Lines For Fluid Line Systems Up To 3000 psi.

AEROQUIP 1503 AND 1502 HOSE is constructed with a synthetic rubber inner tube, a reinforcing layer of single wire braid, and an oil and mildew resistant cotton braid cover. Tube sizes from ¼" through 2½".

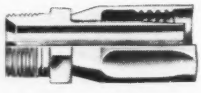


AEROQUIP 2651 AND 2652 HOSE features the same tough construction as 1503 Hose, but has an oil, mildew and abrasion resistant rubber cover. Tube sizes from ¼" through 3".

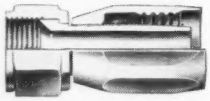
Dash size (in 1/16 in.)	4	5	6	8	10	12	16	20	24	32	40	48
O. D. Tube size	1/4	5/16	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2	2	2 1/2	3
Hose I. D.	3/16	1/4	5/16	13/32	1/2	5/8	7/8	1 1/8	1 3/8	1 13/16	2 3/8	3
Hose O. D.	33/64	37/64	43/64	49/64	59/64	1 5/64	1 15/64	1 1/2	1 3/4	2 7/32	2 7/8	3 19/32
Working psi.	3000	3000	2000	2000	1750	1500	800	600	500	350	250	200
Min. burst psi.	12000	10000	9000	8000	7000	6000	3200	2500	2000	1400	1000	800
1503-1502 Hose Min. bend radii	1 5/16	2 3/16	2 5/8	4 5/8	5 1/2	6 1/2	7 3/8	9	10 1/2	13 1/4		
2561-2652 Hose Min. bend radii	3	3 3/8	4	4 5/8	5 1/2	6 1/2	7 3/8	9	10 1/2	13 1/4	24	33

ALL DIMENSIONS IN INCHES

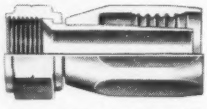
END FITTINGS AVAILABLE



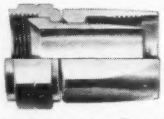
Male Pipe—¼" to 3"



J. I. C. Swivel—¼" to 3"



S. A. E. Swivel—¼" to ¾"



P. T. T. Swivel—1" to 2"

Special Elbow Fittings Are Also Available

Aeroquip 1503, 1502 and 2651, 2652 Single Wire Braid Hose and Reusable Fittings offer many advantages in the design of medium pressure fluid line systems. Recommended for hydraulic, lube and fuel oil, water and air lines, Aeroquip Flexible Hose Lines are superior in installations subject to vibration, stress or flexing. Because of their flexibility, Aeroquip Hose Lines are easy to install in confined spaces, with fewer elbows or adapters than are required with rigid piping or tubing.

REUSABLE HOSE FITTINGS

All Aeroquip Fittings are detachable and reusable. Fittings and hose can be assembled and disassembled quickly. With a supply of bulk hose and reusable fittings, hose assemblies can be made quickly and in quantity in the manufacturer's plant—without need for expensive swaging machines. Another advantage is that hose assemblies on engineering mock-ups can be modified and installed in seconds, using standard bench tools.

The equipment purchaser also benefits because Aeroquip Hose Lines can be replaced quickly and inexpensively right in the field, and the fittings used again and again.

SPECIFY AEROQUIP FOR QUALITY

Aeroquip quality standards are the highest in the industry. From raw materials to workmanship to final inspection, precise, accurate quality control is maintained, resulting in Aeroquip Products that give dependable performance under the most severe operating conditions.

Aeroquip produces a complete line of more than 55 different types of flexible hose—all with matching, reusable fittings—for almost every fluid-carrying application.

Full information is available. Aeroquip Industrial Catalog No. 200 gives complete information on hose, fittings and couplings for industrial applications, plus valuable reference that will help you solve many fluid line design problems. Or write for handy 16-page guide that tells how to plan and install flexible plumbing. Fill in the coupon today.

Complete engineering assistance is available to manufacturers.

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PRODUCT ENGINEERING NEWS

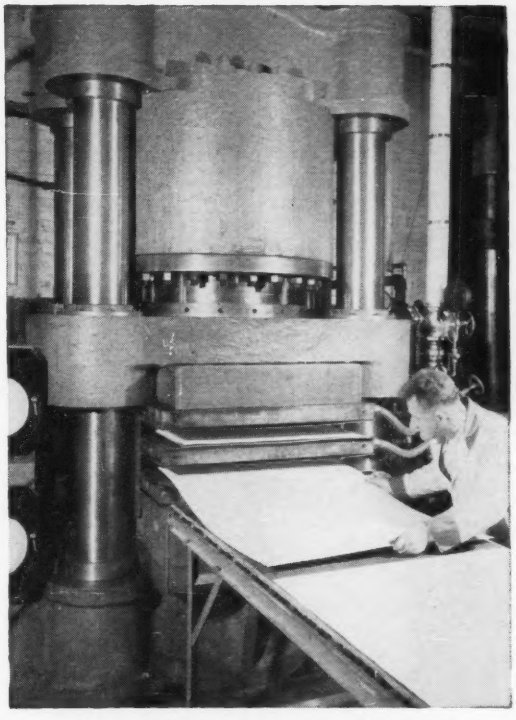
PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

Large Sheets of TEFLON* Moulded in Canada

Jos. Robb & Co. Ltd., and Anchor Packing Co. Ltd. Announce New Production Facilities

Du Pont's tetrafluorethylene resin, "Teflon", is being moulded into large-size (36″ x 36″) sheets by Jos. Robb & Co. Ltd., 5575 Côte St-Paul Road, Montreal, the company recently announced. This marks the commencement, in Canada, of a new product line which has shown amazing growth in the United States in recent years.

"Teflon" has an exceptional combination of properties not found in any other material. It is characterized by virtually complete chemical resistance, non-toxicity, extremely low coefficient of friction, moderate flexibility even at extremely low temperatures, outstanding electrical insulation properties including very low loss at high frequencies, together with sufficient heat resistance to permit exposure to continuous temperatures in the order of 500°F in many uses. As a result, the material is finding wide acceptance for gaskets, packings, valve rings and discs, and diaphragms which require its chemical resistance, flexibility and self-lubricating properties; bearings, non-adhesive coatings, mould-release coatings, and other machine parts, tank and duct linings, etc. . . . which require low friction and non-adhesive properties; high-temperature hook-up and magnet wire covering, coaxial cable insulation, and a variety of moulded electronic parts which utilize its remarkable dielectric and heat-resistant properties.

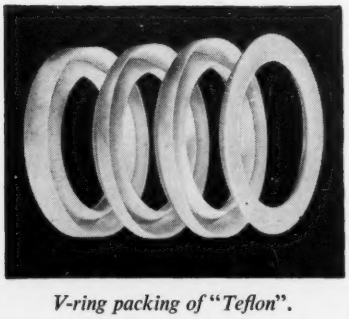


1800-ton press making Anchor "Teflon" Sheet.

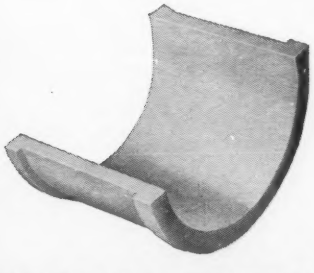
In addition, Jos. Robb & Co. announced that other forms, such as rod, tube and film, can also be made from "Teflon" and that special shapes or mouldings can be produced to customer's specifications.

This is a very positive step forward in the creation of products to meet specific Canadian needs, using the most up-to-date materials available. "Teflon" is only one of a family of outstanding engineering materials sold in Canada by Du Pont Company of Canada (1956) Ltd., and through the use of which many sound business opportunities are developing in the Canadian market. Let us tell you more about them. Call or write our Technical Service Representative, or fill in the coupon (overleaf) for further general information.

OVER



V-ring packing of "Teflon".



Moulded saddle bearing of "Teflon".

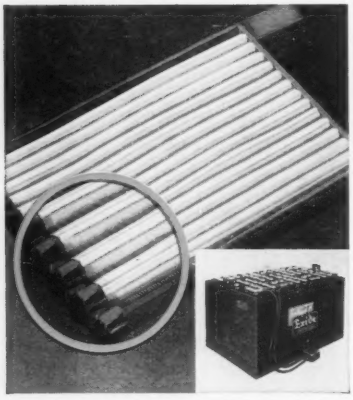
*Trademark of E. I. Du Pont de Nemours & Co. (Inc.)

DU PONT CANADA

PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

ZYTEL* nylon resin fills need for long wearing, lightweight parts in new speed governor



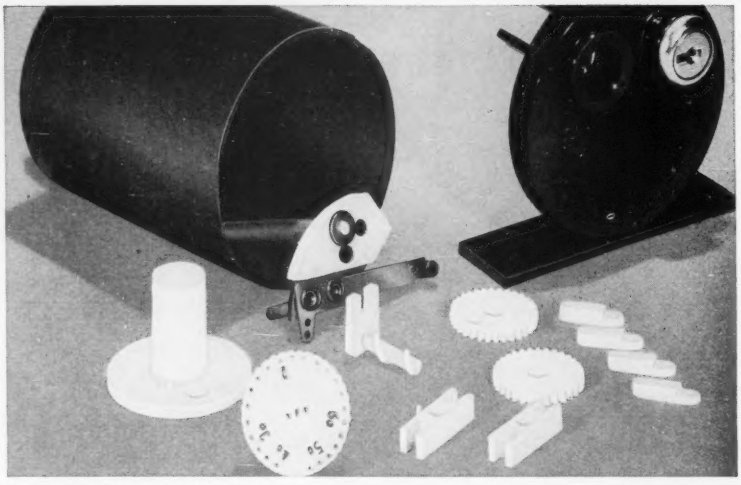
Slotted tubes of ALATHON* extend battery life

THE TUBES in this Exide-Ironclad industrial battery are extruded from "Alathon" polyethylene resin. They are slotted, as shown in the illustration, to permit the active material on the surface of the core to be exposed to the electrolyte. With these slotted tubes, the active material is retained better during the charge-discharge cycle and the working life of the battery is extended.

The decision to switch from rubber tubing material to "Alathon" was made by Exide after years of research, field testing and successful use. Exide engineers expect an increase of up to 20% in battery working life as a result.

"Alathon" won't corrode or erode. It is lightweight, flexible, and strong. Low temperatures will not affect the strength and flexibility of this engineering material. (Batteries manufactured by the Electric Storage Battery Company, Philadelphia, Penna.)

FOR MORE INFORMATION, MAIL COUPON



Including the case, fourteen parts of Du Pont "Zytel" nylon resin are used on this governor. "Zytel" is durable and provides the lightness necessary to minimize inertia—the parts weigh only 5½ ounces. Parts molded of "Zytel" by F. J. Kirk Molding Company, Clinton, Massachusetts.)

THIS SPEED GOVERNOR is mounted under the dashboard of a car or truck. When allowable speed is exceeded, a set of contacts in the governor breaks the vehicle's ignition circuit and thus controls the vehicle's speed.

Including the case, fourteen parts of Du Pont "Zytel" nylon resin are used on the governor. "Zytel" offers the good electrical properties needed in this application and is light in weight to help minimize the inertia of the moving parts. It also offers exceptional abrasion resistance and bearing properties which help reduce wear. In a recent test, the governor was run continuously for two weeks at a speed equivalent to 600 mph. Absolutely no wear was visible on the bearings, gears or other moving parts.

Intricately shaped precision pieces like gears and bearings can be mass-produced by the injection molding process when made of "Zytel"... these parts usually require no further finishing. The method is efficient and can mean substantial savings in production costs.

For complete information on properties and application data of Du Pont "Zytel" nylon resin, write to Du Pont Company of Canada (1956) Limited, Chemicals Department, P.O. Box 660, Room A-4, Montreal, Que.

DU PONT COMPANY OF CANADA (1956) LIMITED,
CHEMICALS DEPARTMENT, P.O. Box 660, Room A-4, MONTREAL, QUE. DE-1

Please send me more information on the Du Pont plastic engineering materials checked: ☐ *"Zytel"*; ☐ *"Alathon"*; ☐ *"Teflon"*; ☐ *"Lucite". I am interested in evaluating these materials for*

NAME _____ POSITION _____

COMPANY _____

STREET _____

CITY _____ PROVINCE _____

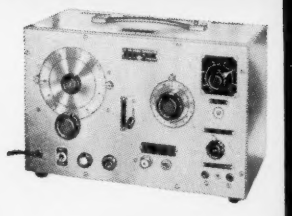
TYPE OF BUSINESS _____

*"Alathon", "Lucite", Teflon" and "Zytei" are registered trade-marks of E. I. du Pont de Nemours & Co. (Inc.)

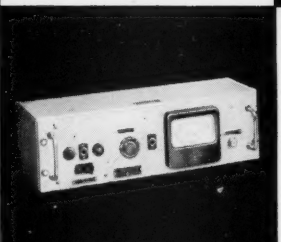
Investigate DuPont engineering materials in your product development programs

One of the family of these versatile engineering materials is often a key factor in product improvement or new product design. The wide range of properties, available with "Alathon"* polyethylene resin, "Lucite"* acrylic resin, "Teflon"* tetrafluoroethylene resin, and "Zytel"* nylon resin, are helping solve industrial design problems.

NEED MORE INFORMATION? Clip the coupon for additional data on the properties and application of these Du Pont engineering materials.

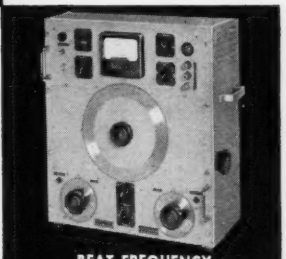


SIGNAL GENERATOR
MS 25

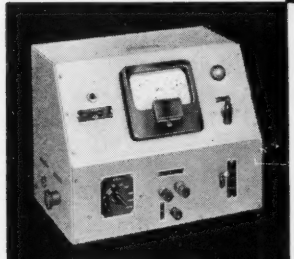


NOISE GENERATOR
TYPE DSG 1

VACUUM TUBE VOLTMETER
TYPE RV 13



BEAT FREQUENCY
OSCILLATOR HO 12

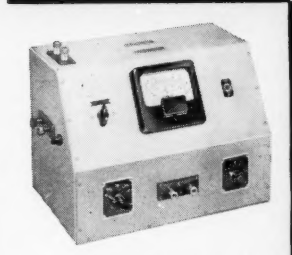


LIMIT BRIDGE TRB 1

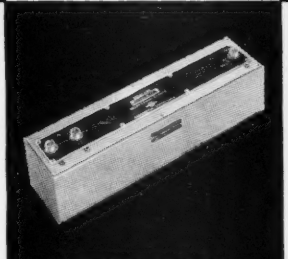
AM STANDARD SIGNAL
GENERATOR TYPE MS 15

DISTORTION METER BKF 5

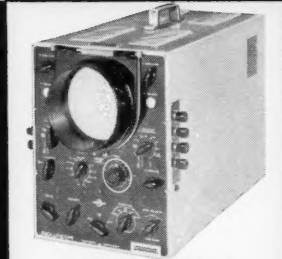
CAPACITANCE BRIDGE
TYPE CMB 1



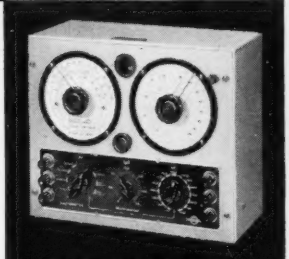
MEGOHMMETER 1 M 3



DELAY LINE KL 41



OSCILLISCOPE OSG 41



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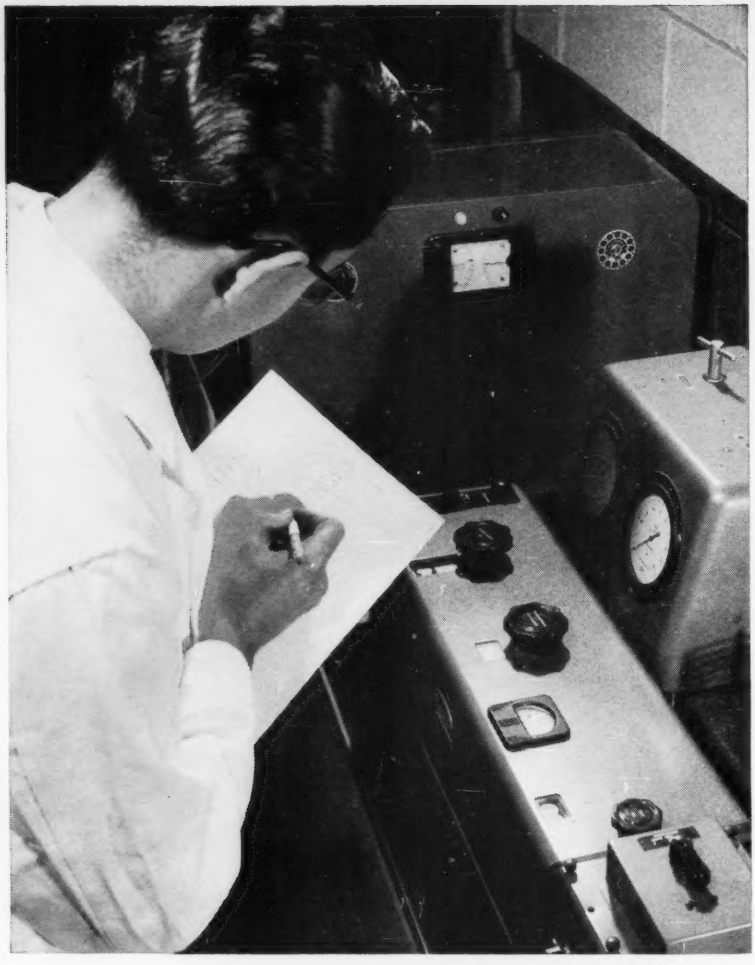

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QUALITY Glidden PRODUCTS

In judging color values, even the keenest expert can be wrong. For color differences are often far too subtle to be detected by the human eye.

That's why, in the Glidden Laboratories, this Spectrophotometer is used to measure color with scientific precision. With it, actual color wavelengths can be recorded. Thus the color standard of an industrial finish, once set, can be matched perfectly anytime. Likewise, the most minute variations in the colors of finishes can be checked.

This is only one of the Glidden Laboratory operations that will ensure your getting finishes that meet every specification. In addition, Glidden Technical Services assist you by developing the most effective ways of *applying* any type of finish you require. Our experts will gladly work with your staff on such tests right in your own plant or in the field.

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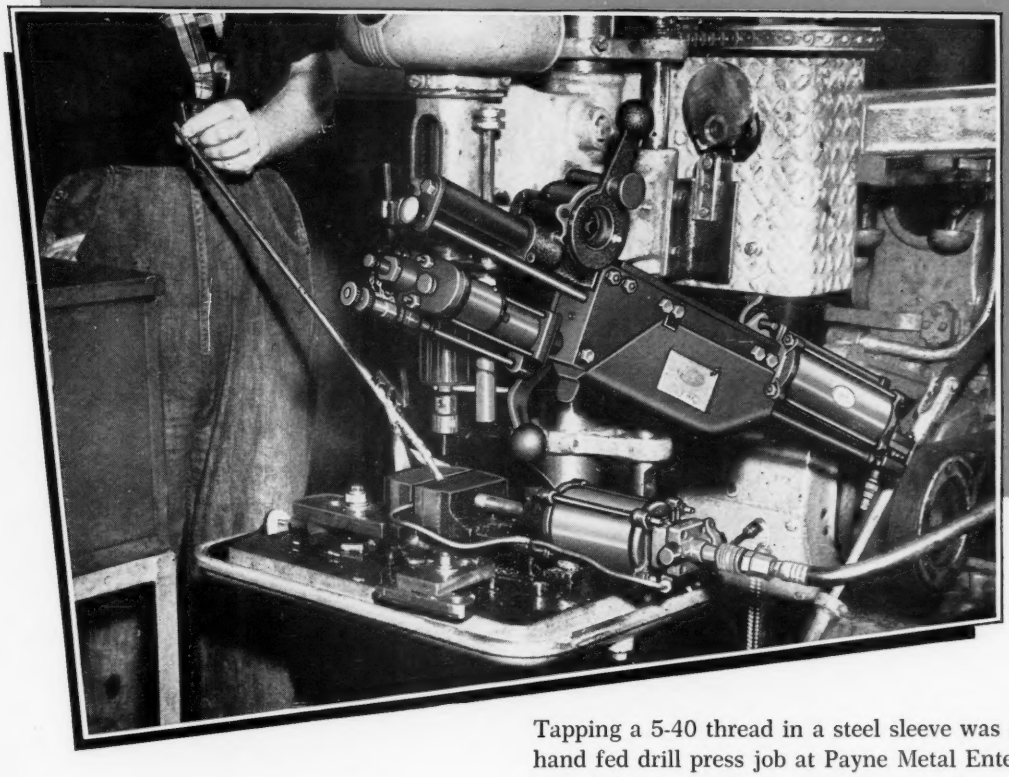
We are now preparing a booklet outlining all the Glidden Technical and Laboratory Services—and how you can profit by them. We would like you to be one of the first to receive one of these free booklets . . . just write to:

THE GLIDDEN COMPANY LIMITED • Technical Service Department, 351 Wallace Ave., Toronto 9, Ont.

WHY Payne Metal Enterprises, Ltd., Toronto tried A NEW WAY of tapping 5-40 threads



Tapping a 5-40 thread in a steel sleeve was a typical hand fed drill press job at Payne Metal Enterprises, Ltd., Toronto. Parts were locked in a vise, and the tapping head fed — by hand. An operator, when fresh, could produce 500 an hour.

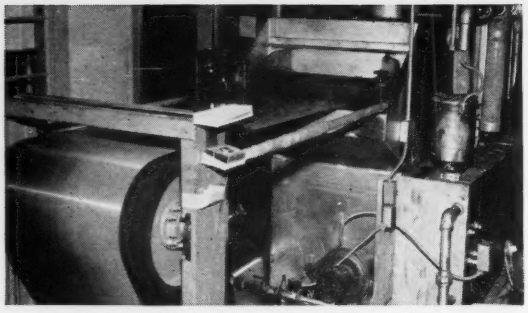
Payne had heard of the success of other Canadian manufacturers with "power feeding" a drill press — called in a Bellows Field Engineer. Asked for ideas.

The simple set-up shown above was the result. A Bellows air-powered Drill Press Feed feeds the spindle, synchronized with a Bellows Air Vise to hold the part. Now the operator feeds parts into a stick-type hopper. Tapping is automatic and the finished part is kicked into a bin by exhaust air. Production? 1900 an hour — almost 400% gain over the old way.

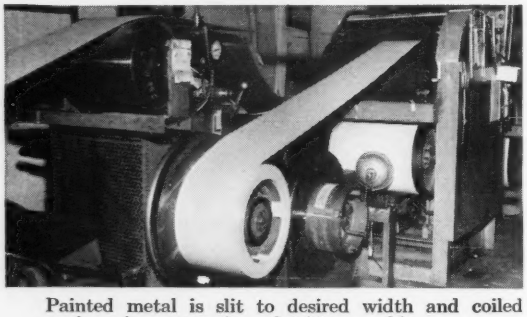
If you have a drill press in your plant, it will pay you well to write for these two free booklets which tell how easily and inexpensively you can install Bellows "Controlled-Air-Power" Devices to obtain faster, lower cost production. Ask for Bulletins ML-3 and DF-110R.

692-B

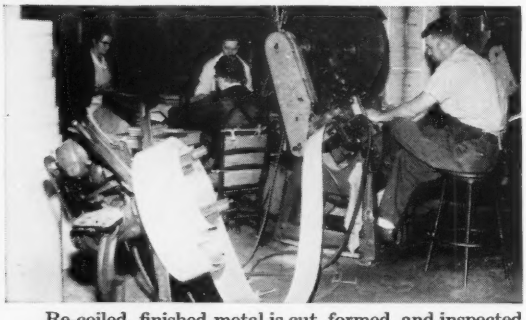
Bellows
PNEUMATIC DEVICES OF CANADA, LTD.
17 Advance Road *Toronto, Canada*



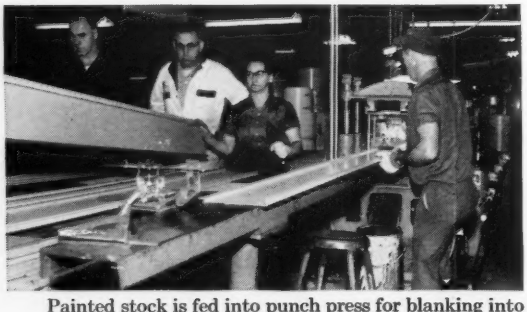
Strip is re-coiled after its treatment with Bonderite, corrosion resistant paint bond.



Painted metal is slit to desired width and coiled again as it emerges from finishing machine.



Re-coiled, finished metal is cut, formed, and inspected here. No loss of paint adhesion.



Painted stock is fed into punch press for blanking into various shapes and sizes.

Photos courtesy Hastings Aluminum Products, Inc.

Bonderized... Painted... Formed...

NO LOSS OF PAINT ADHESION!

Here's a production wrinkle that more and more manufacturers are using: Finish metal in the strip, then fabricate the product.

The technique applies equally well on steel and aluminum. First, run the strip through the Bonderite machine to produce the phosphate integral surface that supplies a secure anchor for the paint. Next, run the Bonderized strip through roll-coat painting and the bake oven. The painted coils of metal are ready for fabrication, and the finish doesn't crack, chip or craze as it is formed, drilled, and punched.

Fabrication after painting, made possible by Bonderizing, saves money by reducing labor, handling and manufacturing area requirements, and allows higher production rates.

Write or call for more information on how you can finish before fabrication in your plant.

Bonderite, Bonderizing, Bonderized—Reg. U.S. Pat. Off.

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BONDERITE	BONDERITE and BONDERLUBE	PARCO COMPOUND	PARCO LUBRITE	TROPICAL
corrosion resistant paint base	aids in cold forming of metals	rust resistant	wear resistant for friction surfaces	heavy duty maintenance paints since 1883

J-M Uneepac automatic ring packing installed in Polished Rod Lubricator-Stuffing Box manufactured by Muskogee IronWorks, Inc., Muskogee, Okla.

Equipment designers of Muskogee Iron Works report:

"Greatly increased packing life... Uneepac guards against pressure damage"

FOR THEIR NEW LUBRICATOR-STUFFING BOXES, design engineers of Muskogee Iron Works needed a packing with long service life as well as foolproof operation. Uneepac, the Johns-Manville automatic ring packing, fully met both of these requirements and contributed to the success and acceptance which the equipment has encountered.

In this application, Uneepac protects itself against damage by excessive gland pressure. The lips of each ring are guarded by the projecting portion of the Uneepac Center section. As a result, far greater service life and reliability is obtainable in this application than with other types of packings.

Uneepac offers many other important advantages for use in pump rods and plungers, compressors and similar equipment. Seals effectively in a minimum of space. Operates with minimum friction. Has excellent pressure sensitivity. Uneepac provides trouble-free operation because each ring positions itself diametrically as well as vertically. Header or follower rings are not always required because each Uneepac ring is a complete, self-protected unit.

To learn how Uneepac may aid your new equipment design, too, write for booklet PK-58A. Just address Canadian Johns-Manville, 565 Lakeshore Road East, Port Credit, Ontario.

JOHNS-MANVILLE JM PRODUCTS

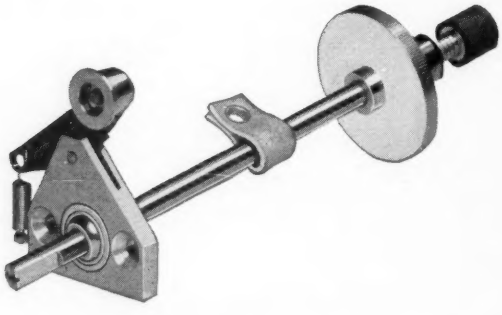
Johns-Manville PACKINGS & GASKETS I-1058

Offset or aligned . . .

HEIM *Unibal* BEARINGS

operate smoothly

The **Diebold Portable Microfilm Camera** weighs only 20 lbs., is about the size of a portable typewriter, yet it is one of the fastest and lowest cost methods of making a copy—a microfilm copy in a split second, that projects to full size onto a brilliantly illuminated reader screen.



The **Heim Unibal Spherical Bearing** consists of a single ball (through which the shaft passes) revolving in bronze bearing inserts which are housed in the bearing body. This Unibal type of bearing has a large surface supporting area; carries heavier loads where required; and corrects shaft misalignment in all directions.

A wide range of stock sizes is carried by Heim distributors across the U.S.A. and in Canada. Heim Unibal Bearings, Heim Unibal Rod Ends, and the complete line of Pillow Blocks, Flanged Bearings, etc. are listed in Heim catalog No. 100. Be sure you have the latest copy in your engineering department.

The **shaft and bearing assembly** shown is the mechanical heart of the Diebold 9600 Portable Microfilm Camera. The rubber roller on the end of the shaft drives film in a film magazine in synchronism with copy being photographed. Smooth operation of this shaft is imperative since any hesitation or binds will show up on the film as density bars in the picture. The shaft rotates in a horizontal position continuously, and, when copy is being fed into the camera, a cam raises the shaft 5 to 10 degrees out of alignment to contact the film. A loose bearing could be used to permit this misalignment, but might result in irregularities. With the Heim Unibal Bearings, the smooth operation necessary is assured in either the offset or the aligned position of the shaft.

RBM BEARINGS CANADA LTD.

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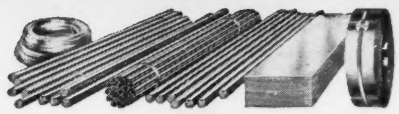
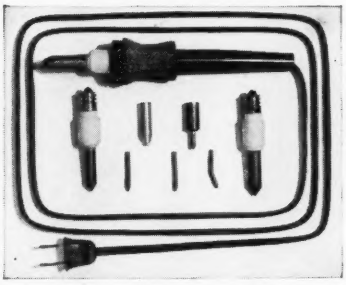


NORANDA COPPER AND BRASS LIMITED

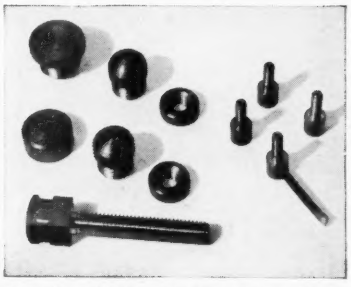
COPPER ALLOY BULLETIN

Noranda COPPER AND BRASS

MILLS AT MONTREAL EAST—OFFICES IN MONTREAL, TORONTO, WINDSOR, EDMONTON, VANCOUVER
Export Department, P. O. Box 1238 Place D'Armes, Montreal, P. Q., Canada



New lightweight soldering pencil uses Noranda Tellurium Copper tips for easier machining, faster and more uniform heating. (Courtesy, Ungar Electric Tool Co. of Canada, Toronto)



Noranda Tellurium Copper gives machining qualities of free-cutting brass, performance of pure copper to these screw-machined parts.

Noranda Tellurium Copper Offers High Conductivity Plus Machinability

Copper made the practical use of electricity possible. It has always been specified by engineers for the manufacture of components for the electrical industry. New applications are still being found to make use of copper's high electrical and thermal conductivity.

Noranda's research facilities are engaged in a constant search for new materials to satisfy the demands of Canada's expanding industries. For instance, manufacturers of electrical components have been looking for a material that combines the conductivity of copper with the machinability of free-cutting brass. In the past, attempts at alloying copper with various elements have produced a harder material without reducing its characteristic toughness.

In Noranda Tellurium Copper we feel we have the answer. Our engineers have found that the addition of a very small amount of Tellurium to copper raises its machinability from 20% of free-cutting brass to 90%. This is accomplished with negligible effect on its other desired properties.

Using Noranda Tellurium Copper, manufacturers of electrical components can increase screw-machine surface speeds up to four times faster than those recommended for pure copper. Tooling required to work Noranda Tellurium Copper is the same as that used on free-cutting brass.

Noranda Tellurium Copper may be extensively hot forged and, although its ductility is slightly lower than that of pure copper, it can be readily cold worked. All these advantages are gained with electrical and thermal conductivities remaining almost as high as those of pure copper.

Applications

Ungar Electric Tool Co. of Canada, Toronto, uses Noranda Tellurium Copper for tips for their versatile, lightweight electrical soldering pencil for hobby and production line work. A number of interchangeable tips of different sizes and shapes are made from 1/8", 5/16", and 3/8" round Noranda Tellurium Copper rod. Complicated drilling and tapping operations take full advantage of its excellent machinability.

Noranda Tellurium Copper was chosen for other reasons, too. Its high thermal conductivity gives uniform heat at the pencil's tip. It tins more readily than other metals and it is less subject to oxidation. These tips heat to 600° F in 90 seconds.

The second application shown is a series of parts for use in the electrical switchgear industry. These were machined from 3/8" to 1-1/4" round, hexagonal and square Noranda Tellurium Copper rod.

The third example is a holder for a current-carrying bimetal contact. Electrolytic Copper was first specified for this part. Its machining characteristics made the important slotting operation difficult. The problem was solved by using Noranda Tellurium Copper.

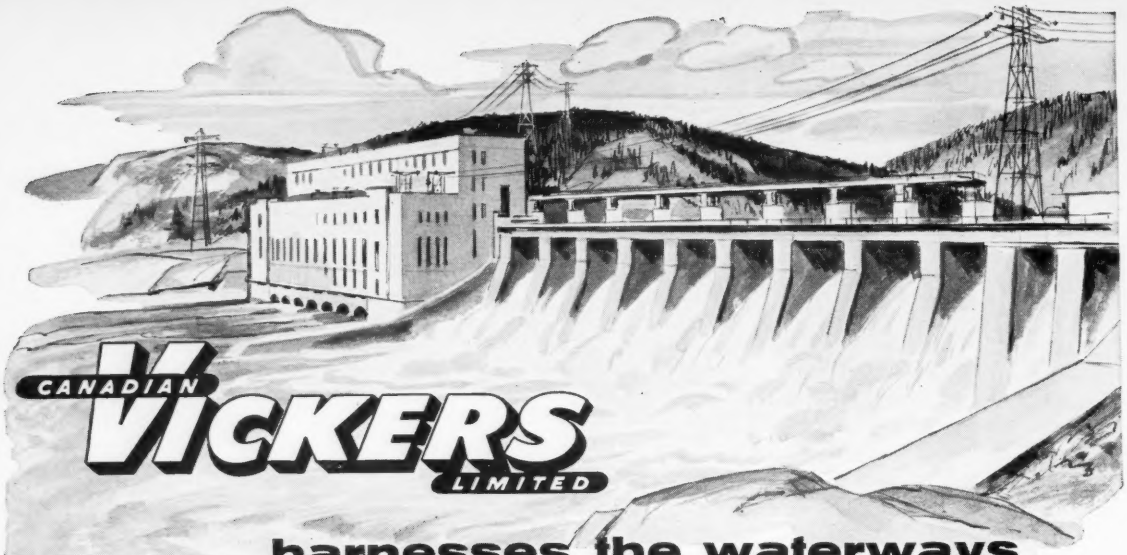
Noranda Research and Service

Tellurium Copper is just one of the many copper-base alloys produced by Noranda to solve specific problems. Each is the result of extensive research and development conducted by the Noranda Laboratory in close cooperation with fabricators and users in terms of their requirements.

Noranda Tellurium Copper, or one of the many other engineered Noranda alloys, may well be the answer to your particular problem. Our Technical Service Department and Laboratory will be glad to work with you on the application of these metals to your products. Contact your nearest Noranda Sales Office for immediate service. (2547)

Chemical & Physical Properties of Noranda Tellurium Copper

ANALYSIS		
Copper %		99.5
Tellurium %		0.5
MECHANICAL PROPERTIES (rod 1-in. dia.)		
Ten. Strength, psi	Hard	48,000
	Half Hard	42,000
Yld. Strength, psi (½" extension)	Hard	46,000
	Half Hard	39,000
Elong. % (2-in.)	Hard	20
	Half Hard	35
Rockwell Hardness	Hard	B50
	Half Hard	B45
PHYSICAL CONSTANTS		
Specific Gravity		8.94
Density, lb/cu. in.		0.323
Elec. Conductivity, % (IACS at 68 F)		90.0
Thermal Conductivity (Btu/sq ft/ft/hr/F at 68 F		205
Mod. of Elas. (Ten.) 10°psi		17
Coef. of Ther. Exp. (per °F, from 68-570 F) x 10°		9.8
FABRICATING PROPERTIES		
Machinability rating		90
Cold working		Good
Hot working		Excellent
Hot working range °F		1400-1600
Comm. anneal range, °F		700-1200
JOINING PROPERTIES		
Soft soldering		Excellent
Brazing		Good
Inert-Gas Arc Welding		Good



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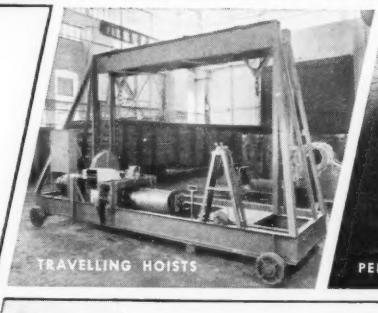
harnesses the waterways of the world!

Many of the world's greatest hydro-electric power developments depend on equipment designed and fabricated by Canadian Vickers.

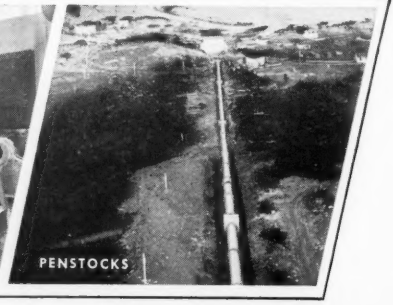
In addition to the examples shown here, Canadian Vickers builds Spillway Gates, Head Gates, Stop Log Hoists, Trash Racks, Butterfly Valves, Lock Gates, and a wide range of other equipment.

World-wide experience, and unequalled craftsmanship and facilities, are available to solve any problem connected with water-power and water-way projects.

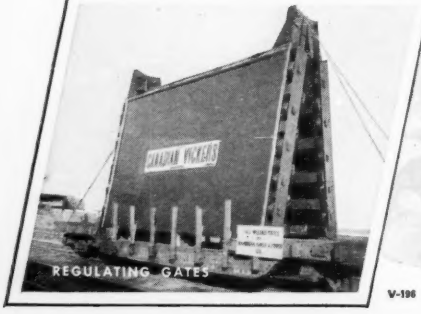
TURBINES



TRAVELLING HOISTS



PENSTOCKS



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TORONTO VANCOUVER

V-196

C·G·E Solves Plastic Molding Problem

...helps Supreme Aluminum develop new pot handle with five important advantages

- **Remains cool**
- **Stainless**
- **Easy-to-clean**
- **Comfortable to hold**
- **Attractive**

Canadian General Electric's Plastic Engineers were able to solve a plastics-to-metal bonding problem in the development of a new pot handle for Supreme Aluminum.

This is just another example of how the experience and facilities of C.G.E.'s Cobourg Plastics Plant have "paid off" for customers.

Solving production problems like this is typical of the kind of service that brings repeat orders time after time from C.G.E.'s customers.

Canadian General Electric offers you complete facilities at Cobourg for every type of plastics molding—injection, compression, extruding and automatic. Call on C-G-E plastics engineers and technicians whenever a new problem or the need for a new product arises. For further information contact: Plastics Advisory Service, Canadian General Electric Co. Ltd., Cobourg, Ontario.

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Industrial Products Department

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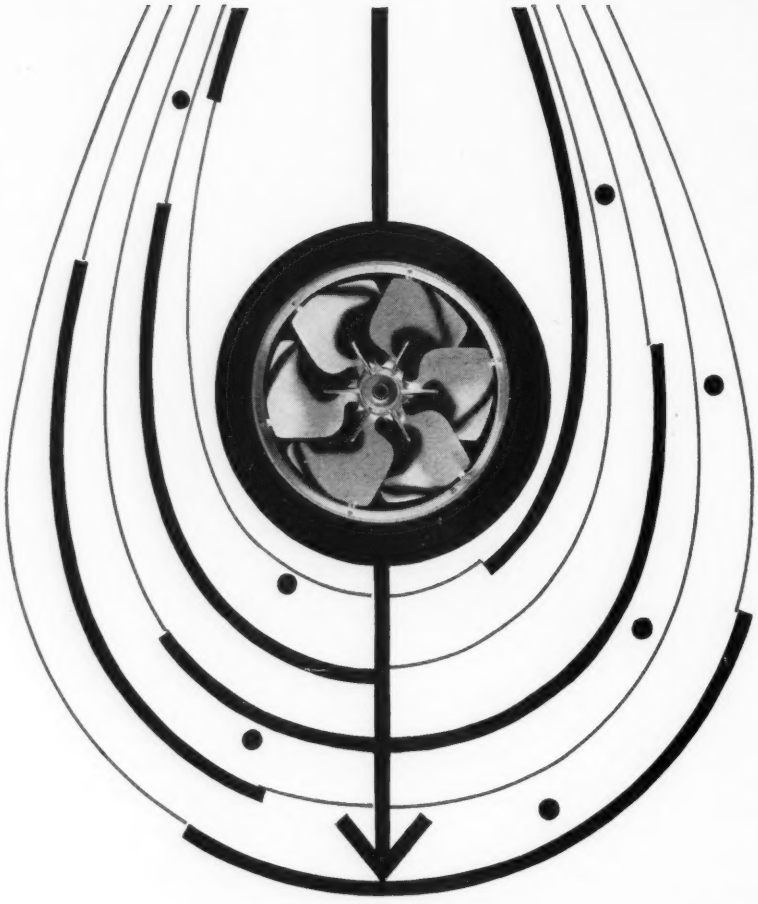

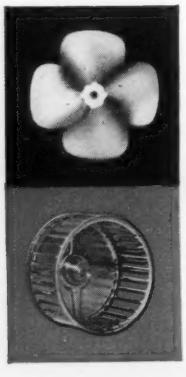

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People

Important people who are in the news

Changes at Honeywell

John H. Fox, P.Eng., John R. Brace and **J. A. MacRae** recently took new appointments at Honeywell.

Fox is appointed v-p in charge of sales. A native of Toronto and a graduate in mechanical engineering from the University of Toronto in 1927, he joined Honeywell in 1935 after several years as assistant to the chief engineer at the C. A. Dunham Co. He is first vice-president of the Association of Professional Engineers.

Brace becomes factory superintendent and MacRae chief engineer of the residential and commercial division. Both are graduates in mechanical engineering from the University of Toronto.

Muller is chief engineer

Promoted to chief engineer at Westinghouse is **H. N. Muller.** He will take charge of all headquarters engineering activity at Hamilton and co-ordinate engineering operations among the firm's plants and divisions. Muller was educated at Dartmouth College where he received his physics degree in 1935. He joined the graduate student training program at Westinghouse the same year. Previous to his latest appointment he was assistant to the vice-president, apparatus products.

A pilot of experience

One of the few pilots with operational experience on all seven continents, **James N. H. Greenshields** has been appointed chief check pilot with Kenting Aviation Ltd. of Oshawa, Ontario.

To say that Greenshields is a flyer with experience would be a masterpiece of understatement. He has just returned from a globe-circling flight having delivered a Canso GKI to Australia. Last winter he was skipper of a Canso crew carrying out an aerial survey for the British Government in the Antarctic. Previous to coming with Kenting he was an airline pilot with BEA. Before that he flew helicopters on geological survey in Egypt and for crop spraying purposes throughout Europe. His wartime experience was similarly varied. After training in Southern Rhodesia he flew Hurricanes and Spitfires for Fighter Command, various aircraft for Ferry Command in the Middle East, Walrus aircraft for Air Sea Rescue and other types for Transport Command based in Aden. In all he has flown over thirty different types of plane.

PSC appoints Larsen

Peder W. Larsen, well known in the aircraft and electronics industry, has been appointed manager of government projects of PSC Applied Research Ltd. He will be in charge of the Toronto company's new Ottawa office.

Larsen is a graduate of London University in electrical engineering and served seventeen years in the Royal Engineers. From 1941 to 1945 he was responsible for the organization of radar inspection with the inspection board, United Kingdom and Canada. In 1945 he returned to Britain where he was engaged in electronic fuse development and later was responsible for the development of army guided missiles.

In 1954 he returned to Canada on the staff of the United Kingdom High Commission where he served until retiring from the army to take up his present position.

Important Alcan appointment

Franklin T. Mathias has been appointed chief engineer with the Aluminum Co. of Canada. He has behind him a distinguished engineering record in industrial and hydro-electric planning, design and construction.

A colonel in the U. S. Army Engineers at 36, he won renown as commanding officer of operations in the building of the Manhattan Project Atomic Bomb Plant and directed a peak force of 45,000 men which in less than two years changed a waste of sagebrush and sand into a complex plant making fissionable plutonium for the atomic bomb. In recognition of his achievements the United States Congress awarded him the Distinguished Service Medal.

Two managers

Two senior appointments have been announced by Linde Air Products Co.

Affected are **R. J. Anderson, BASc, PEng,** who becomes manager, engineering and sales services and **R. A. Schmidt, BS, PEng,** who becomes manager, production.

Anderson is a graduate of the University of Toronto in electrical engineering and has, for some years, been manager, engineering service, with the company.

Schmidt, a graduate in chemical engineering from the University of Notre Dame, was general superintendent.

News from Lyman Tube and Bearings

It was recently announced that **Philip B. French** has been appointed vice-president in charge of sales at Lyman Tube and Bearings Ltd.

Two at CDC

Two new appointments in the technical division of Computing Devices of Canada have been announced.

Mr. A. W. Duguid becomes manager of engineering and development and **Mr. R. E. Freeman** is the new manager of manufacturing. Duguid is a Rhodes Scholar with a degree in honor physics and from 1953 to 1956, he was at the Canadian Armament Research and Development Establishment in Quebec as guided missile project officer.

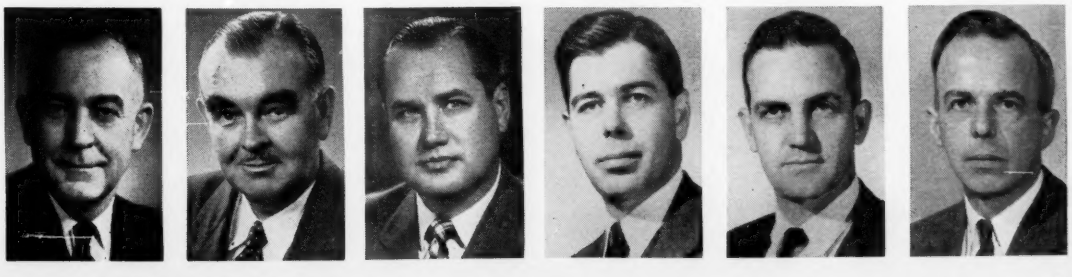
Freeman is a graduate of Queen's University with postgraduate work in electronics. From 1951 until he came to CDC he was manager of the special projects department of Canadian Arsenals Ltd.

Rae of Atlas Steels

Arthur C. Rae has been appointed director of sales at Atlas Steels Ltd.

A native of British Columbia, he graduated from the University of British Columbia in 1941 with the degree of BSc in metallurgical engineering and then joined Atlas. Rae succeeds R. M. Davis following the recent appointment of Davis as assistant to the president, H. George De Young.

Mathias **Anderson** **Schmidt** **Duguid** **Freeman** **Rae**



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Of course, this is only *one* of a whole family of corrosive resistant fastenings which we carry in stock.

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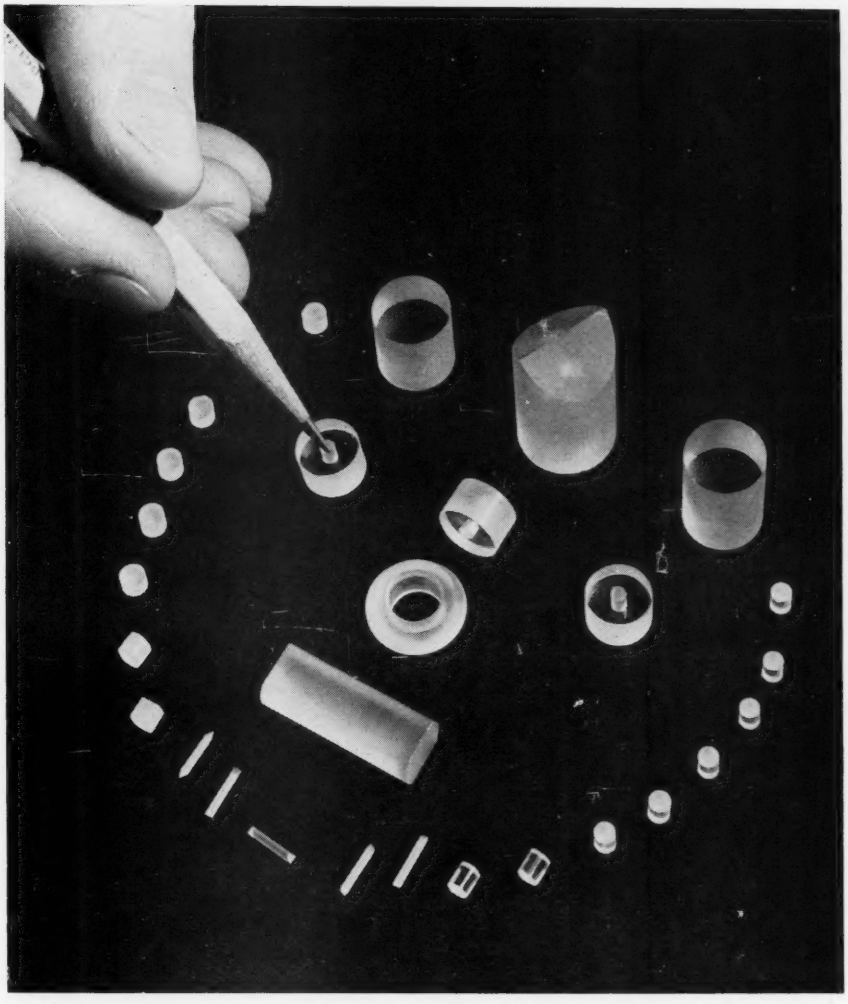


Synthetic sapphires can take any shape by cutting, grinding, polishing and flame-forming.

Man improves on Nature's sapphire

Industry turns to the man-made sapphire for top quality gemstones

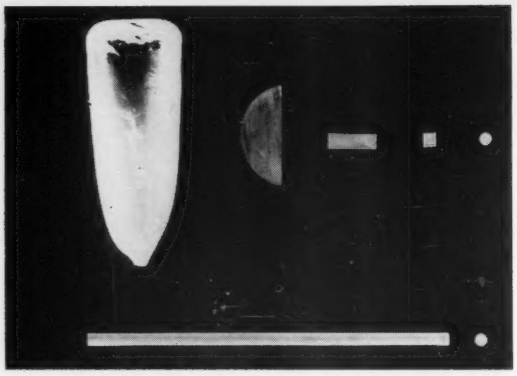
F. L. Neuman, P.Eng. LINDE AIR PRODUCTS

Are you looking for something that is extremely resistant to wear, heat and corrosion, has excellent optical properties, a low coefficient of friction and high dielectric strength, and can be fabricated to practically any form?

Then synthetic sapphire may be the answer to your design problem, as will now be explained.

Because of its many superior properties, sapphire is being used for spacers, tube supports, spreaders and insulators in electrical devices, and for small parts that must withstand extreme wear, such as bearings, precision gauges, orifices, and thread guides.

And if you are designing for an extremely smooth scratch-free surface, then these man-made gemstones, in powder form, will provide the answer.



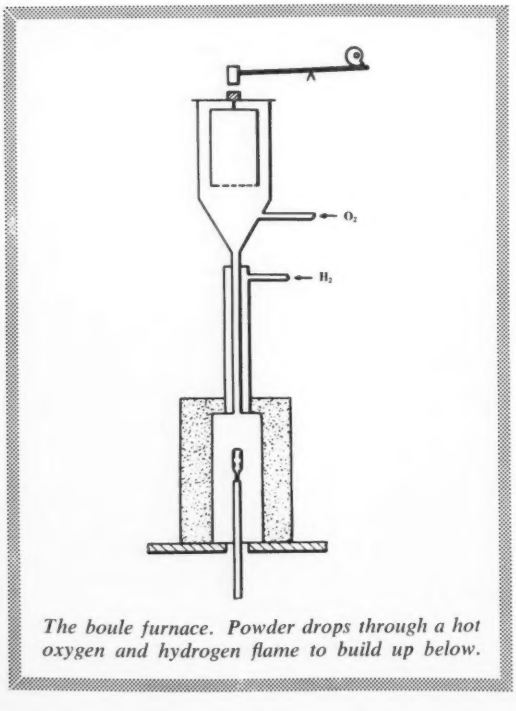
Sapphire bearing blanks cut from boule and from rod.

The challenge of growing gems synthetically has piqued the imagination of man through the ages. However, it was not until 1904 that the first gemstones—ruby and sapphire—were synthesized commercially. Since that date, the original Verneuil process has been used, with modifications, to manufacture quantities of corundum and spinel. Sapphire and ruby are varieties of corundum (aluminum oxide); spinel is composed of magnesia-alumina crystals.

Almost all synthetic corundum and spinel were made in Europe, where they had a ready market as bearings in the Swiss watch and instrument industry.

During World War II, the demand for jewel bearings for instruments sparked the beginnings of the industry in North America. Linde's U. S. associates developed a process and began manufacturing synthetic corundum and spinel on a large scale.

At first, these synthetic crystals were important mainly as gem materials, with their use as raw materials for jewel bearings coming second. Now, however, a significant portion goes into such items as friction parts and bearings for watches, electric watt-hour meters, compasses and precision instruments.



The boule furnace. Powder drops through a hot oxygen and hydrogen flame to build up below.

The synthetic sapphire and ruby are used industrially almost to the exclusion of the natural stones, because of their much higher quality.

In making synthetic sapphire, alum is first calcined and purified by precipitation from aqueous solutions. Various colors are obtained by adding metal oxides to varying proportions of the uncalcined alum.

The calcined powder is screened and placed in a hopper having a fine-mesh screen bottom. The powder drops intermittently into a very hot flame of oxygen and hydrogen. The powder melts and builds up a sintered mass on the top of a ceramic pedestal and a rodlike crystal begins to grow from the mass. By careful control, this crystal grows until it is about ¼ in. long and the diameter of a match stick. Then, conditions are changed so that a small ball forms on top of the rod which broadens to resemble a mushroom, called a boule.

When the diameter of the mushroom has increased to standard boule size, another adjustment generates a cylindrical section of uniform diameter. When the desired length of boule is reached, the growth process is stopped and the boule cooled.

Synthetic sapphire and ruby come in four basic forms:

Boules. Whole, annealed and half boules, up to ¾ in. diameter and up to 5 in. long in some diameters. (The name comes from the ball-shaped crystal obtained by Verneuil.)

Rods. Single crystals up to 0.230 in. diameter and 18 in. long in some diameters. These are supplied centreless-ground in all diameters; as-grown or flame-polished in some diameters.

Balls. Single-crystal sapphire spheres, 0.025 in. to ⅝ in. diameter. Sphericity tolerance: 0.00002 in. on balls ⅛ in. or smaller.

Discs. Single-crystal sapphire windows, ½ in. to 3 in. diameter; 1mm. to ⅛ in. thickness. Greater thickness is available for diameters up to ¾ in. They are supplied with ground finish or window glass polish.

Sapphire has found the widest industrial use of all the synthetic gem crystals. Its development in long-rod form permitted development not possible with boule sections. Rods can be bent (or sliced) and have useful applications in that form as thread guides and bearings.

A few uses follow for synthetic sapphire in its various shapes.

Optical Systems. Synthetic sapphire's unique combination of properties make it ideal for optical systems that require resistance to abrasion, resistance to corrosion, high temperature strength and high mechanical strength, in addition to a high percentage of transmission in important ultra-violet and infra-red regions.

Discs of synthetic sapphire 1.5 mm. thick will transmit radiation over wave lengths of 0.17 to 6.0 microns. At these limits, 40% of the incident radiation is transmitted, from 1.0 to 5.0 microns, over 85% is transmitted.

One interesting use is as entrance and exit windows in infra-red analyzers. These analyzers are used in industry to control quality in the production of ethylene and butadiene and to detect carbon dioxide in hydrocarbon streams or methane and ethane in ethylene.

Selection of window material is based on range of transmission and durability. Windows must transmit a high percentage of infra-red radiation in the major band of the gas being analyzed. When there is inter-

Table 1. Typical Uses for Synthetic Sapphire and Ruby

FOR	IN	REMARKS
Bearings	Watch, meter and instrument jewels; journal and thrust bearings up to ¾ in. OD; ball bearings.	Hard, wear and corrosion resistant; low friction unicrystalline. Textile, wire, tape and film.
Precision gauges	Plug, ring and depth. Also anvils, blocks and points.	Unicrystalline; wear and corrosion resistant; hold high polish.
Guides	Textile, wire, tape and film.	Hard, wear and corrosion resistant; resist dust and dirt accumulation; low friction.
Stylii	Recording, playback and recording chart.	Unicrystalline, hard, wear resistant; low friction.
Wear parts	In electrical or mechanical devices cameras and projectors; instruments.	Hard, wear resistant, low friction; hold high polish; unicrystalline.
Balls	Bearings, check valves, ball points for pens, viscosimeter spheres and rotameter floats.	Wear and corrosion resistant; high precision; low friction.
Dies	Soft metal and plastic drawing; coating and wire coiling; wire guide; extrusion.	Hard, wear and corrosion resistant; unicrystalline; hold high polish; impart smooth finish.
Tools	Soft metal cutting, burnishing, honing, scoring. Hold high polish and true cutting edge. Impart burnished finish to part.	Hard and resistant to wear.
Orifices	Oil burner nozzles, diesel injector, spray nozzles, metering orifices.	Wear, heat and corrosion resistant; resist residue accumulation.
Optical	Lenses, prisms, flats, light pipes; combustion and chemical vessel windows.	Excellent infra-red and ultra-violet transmission characteristics; heat and corrosion resistant.
Electrical	Electronic tube supports, insulators.	High dielectric strength, non-porous, easily degassed; resistant to heat distortion.
Gemstones	Brilliant gemstones in various colors and cuts. Also titania gemstones.	Hard, wear and corrosion resistant.

ference from another gas present in the sample tube, it is sometimes necessary to select a window material that will restrict the spectral range of the instrument.

Sapphire has advantages over other window material in reducing this interference in many cases.

Sapphire discs can be used advantageously for elements in certain lenses because sapphire has a large reciprocal dispersion for the index of reflection. Compared with the same type of lens made with conventional materials, sapphire gives superior performance. Strain and optical anisotropy limit its use as a precision lens element. However, its resistance to abrasion makes sapphire valuable for outer elements of lenses, the surfaces of which must withstand considerable abuse.

Light pipes. The high index of refraction and excellent high temperature properties make sapphire a desirable material for light pipes that must be used in a high temperature corrosive environment.

Light pipes are used to transmit light from within a furnace to an outside measuring device. This allows temperature to be taken without opening the furnace. In the ultra-violet regions, sapphire is useful as a window material in equipment for the study of photochemical reactions involving ultra-violet radiations. It can also be used for windows in combustion vessels.

Because of its extended wave-length transmission range, unusual dispersion, mechanical strength and chemical inertness, sapphire should be considered for use where more standard materials have proved inadequate.

Guides. The availability of sapphire in long-rod form permits developments not possible with boule sections.

See overleaf, then page 60 ▸

Table 2. Properties of Linde Synthetic Sapphire

Composition
100% aluminum oxide (Al_2O_3)

Crystal Structure
Hexagonal (Single crystal, not a sintered product)

Finish
Optically clear

Melting Point
2040 deg C

Hardness
Knoop: 1525 to 2000
Mohs: 9

Specific Gravity
3.98

Specific Heat
0.18 calories per gram at 20 deg C

Porosity
Nil

Chemical Resistance
Practically inert to most reagents at room temperature.
Inert to a large variety of reagents even at high temperatures (over 1000 deg C)
Acid resistance excellent, attacked by hot alkalis.

Thermal Conductivity
0.065 calories /cm² /sec /deg C /cm

Thermal Expansion
Mean linear expansion coefficient.

Temperature	Parallel to C-axis	Perpendicular to C-axis
50 deg C	66.66×10^{6}	5.0×10^{6}
500 deg C	8.33×10^{6}	7.70×10^{6}
1000 deg C	9.03×10^{6}	8.21×10^{6}

Electrical Resistance

500 deg C	1000 deg C	1500 deg C
10^{11}ohm-cm	10^{6}ohm-cm	10^{4}ohms-cm

Dielectric constant and power factor (Loss tangent)

	Field Parallel to C-axis		Field Perpendicular to C-axis	
Frequency (megacycles)	Dielectric constant	Loss tangent	Dielectric constant	Loss tangent
300	10.6	<0.0001	8.6	<0.0001
100,000	——	——	11.0	0.0002

Dielectric strength
Approximately the same as sintered aluminum oxide, namely: 480,000 volts per cm.

Optical transmission

Ultra-violet (Sample 2 mm thick)	Infra-red (Sample 1 mm thick)
66% at 2000 Angstrom	92% at 3 microns
20% at 1500 Angstrom	50% at 6 microns

Compressive strength
300,000 psi at 77 deg F

Young's Modulus
50 to 55 x 10^{6} psi, depending on position of crystal C-axis.

Modulus of Rupture
40 to 130,000 psi at 30 deg C.
23,000 to 50,000 psi at 540 deg C.

Sealing characteristics
High and low temperature seals can be made to metals, glass and ceramics.

Available forms
Windows, cylinders, tubes, rods, balls and special shapes.

A swing frame grinder fitted with a 6-in. bore flexible hose which extracts the abrasive and glowing waste.

Flexible hoses — arteries of industry

As yet there is no all-purpose flexible but improvement is constant

Very few industries could exist without using some form of flexible tubing or hose, so it is no exaggeration to claim that they are the arteries of industry, in the same sense that electric cables are the nerves. Since the only mode of conveyance between a fixed and a moving point is through a flexible, it can be seen that the subject is extremely broad and complex.

Thousands of different flexibles are available, but unfortunately only a few people have more than a hazy outline of the different types and their potentialities. The selection of a particular flexible for a particular job is mainly the responsibility of the development engineer or the drawing office, but it is obviously desirable that all engineers responsible for the operation and maintenance of plant and machinery should be aware of the problems involved.

One important point which is not always realized is that flexibles are expendable. Their life depends entirely on the conveyant and the operating conditions: some can be expected to last for 10 years or more, others will have a life calculated only in weeks. Manufacturers of flexibles are continually trying to improve their products and are also producing new ones for special applications, but there are still a few requirements for which no suitable flexible yet exists.

The ideal would be the production of a composite hose using various materials which could cater for **all** conditions, but this is far from possible at the moment. Many materials can be mixed, plied, coated or interleaved to meet a number of conditions reasonably allied to one another, but one or other of their qualities is apt to be canceled out for more widely different conditions and conveyants. Obviously, there must always be a different construction for hoses which are required to be light and extremely flexible as against others required for heavy duty, where such physical characteristics would, in fact, be a liability. In the constantly widening range of liquids and chemicals, some hose materials which are satisfactory for one might well be perfectly useless or even dangerous of use for others. Progress is being made in narrowing down and rationalizing hose design to cover as great a range as possible within the

The facts a supplier must know

There are many instances where a number of different flexibles could be used for the same job. Often it is relatively unimportant which type is chosen and the deciding factor can be the question of cost. It must be stressed, however, that when ordering flexibles, all possible information must be given to the prospective supplier, so that he can appreciate exactly how the flexible is to be used and what the operating conditions are likely to be. This may appear to be elementary, but many cases come to mind of a flexible giving unsatisfactory service, although after detailed investigation it is generally found to be the fault of the user, who has failed to disclose some vital factor.

An enquiry for flexibles should always include the following important details:

Internal diameter.

External diameter (if important).

Quantity of flexibles required.

Length (if fitted state whether over-all or between fittings).

Conveyant.

Maximum and minimum working temperature (if important).

Maximum and minimum working pressure, stating if fluctuating or, if for suction, details of vacuum.

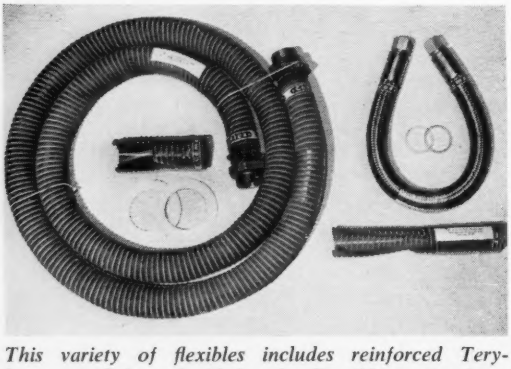
Type and size of end fittings required and if to be supplied fitted.

Will tube be static? If not, state angle and periodicity of flexing and vibration.

Bend radius.

If frictional loss is important, state flow required in gallons (or cu. ft.) per minute.

General conditions of application, including external conditions (if important).



This variety of flexibles includes reinforced Terylene smooth bore, braided and collapsible venting hose.

capacity of each make-up but, even so, caution will always be necessary in the matter of choice and the advice of an expert should be sought always where there is an element of doubt.

One of the first steps in the development of flexibles, as they are known today, was the "flexible link" on the ball and socket (or knuckle joint) principle, which led eventually to the present metallic interlock hose. The introduction of rubber was a major step forward, particularly when methods of extruding it into tubes were perfected, and even greater strides were made after the discovery of synthetics which have rubber-like qualities with the added advantage of resistance to oil. The innovation of plastics subsequently led manufacturers to copy rubber hoses by using a plastics wall for certain applications.

It then became necessary to strengthen the tube or hose wall, on account of its tendency to burst under internal or external pressure, and gradually means were discovered of reinforcing the rubber or plastics by the addition of various supporting materials, such as embedding a wire helix in the wall, by the insertion of a woven fabric or wire mesh braiding and by using them as outer protective covers.

The basis of all flexibles at that time was that each category of hose utilized one basic material for the wall and other materials were added to assist it in various ways. Slowly, industry realized that the emphasis of their development work was concentrated on the wrong part of the problem. Up to now, work had been concentrated on investigating the properties of each specific material, whereas what was wanted was a comprehensive study of the applications of flexibles, embracing every type of material on one side and all the known uses and purposes of flexibles on the other. During investigation, a new method was discovered of supporting woven fabric or pressed fibre materials by mandrel-wrapping them between an inner and outer wire helix or other cords. This had the double advantage of ensuring a constant bore and complete flexibility. The outcome was the composite hose, in which practically any ductile or flexible material can be used in fabric, sheet, film or other similar form.

The growth of flexibles inevitably followed the development of complicated machinery which depended on the local transmission of power (water, air, oil or steam) and/or communication between moving, movable, vibrating or misaligned component parts. In the formation of all hoses, therefore, it is necessary to meet an infinite variety of working conditions, quite apart from any liquids which may be passed through the hose or solids which it may encase or protect.

These conditions could be briefly summarized as follows:

Pressure: High, low or negative internal and external pressures.

Flexing: High or low frequency vibratory flexing; continuous or periodic mechanical flexing; manual flexing.

Temperature: High or low internal and external temperatures.

Abrasion: Internal or external abrasion.

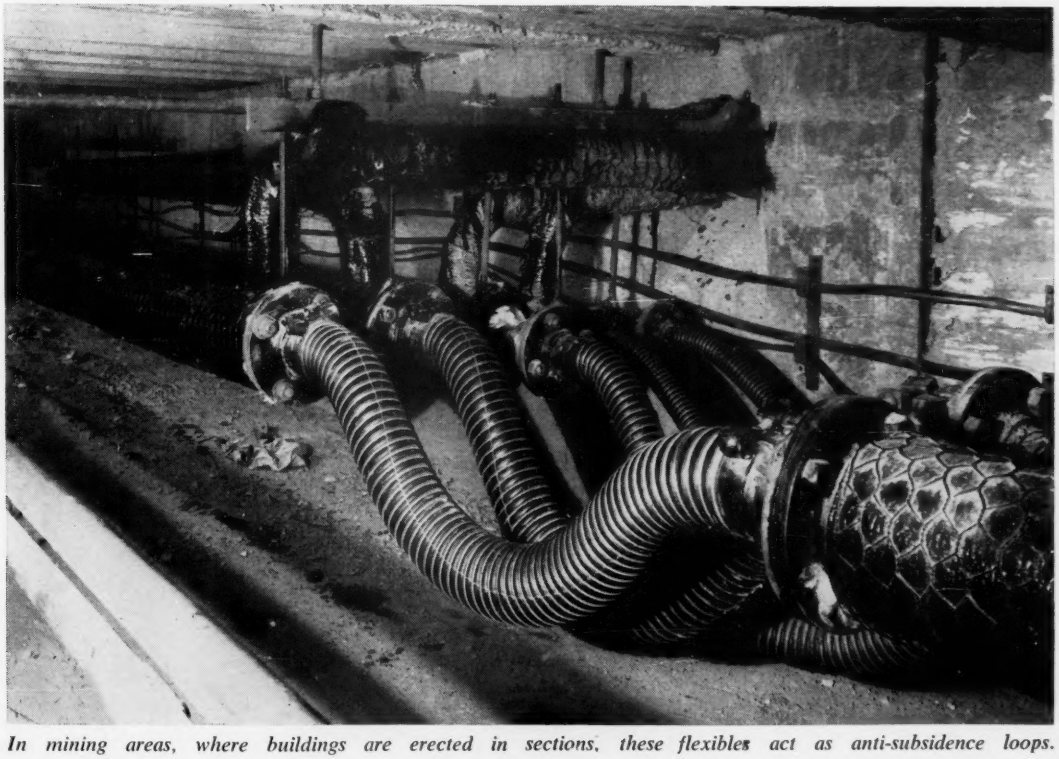
Conveyant: Air, gas, oil, steam, liquids or solids (including the complete list of chemicals).

In most of these applications, the weight and strength of the hose are highly important, as is also the point of frictional loss or elongation under pressure. Costs also have an important bearing on quality and make-up.

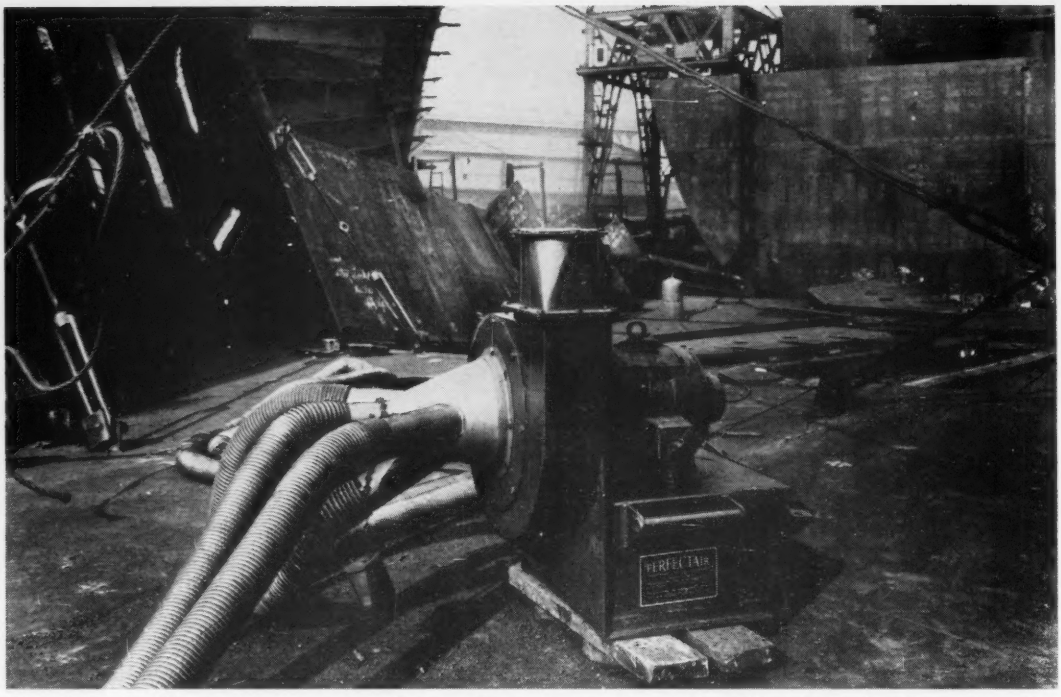
At one time it was possible to meet certain conditions, such as crush resistance and higher internal pressures, merely by increasing the wall thickness of, for example,

Flexible hoses exhaust the gasoline fumes from aircraft White bands support wires to carry away static charges.

"It is obvious that no one material can meet aii operating conditions"



In mining areas, where buildings are erected in sections, these flexibles act as anti-subsidence loops.



This light, flexible air hose is used with an exhaust fan to draw off welding fumes in ship construction.

a rubber hose, but such a course is not always possible or desirable today, even if the vital question of cost is disregarded.

All basic raw materials and synthetic materials so far produced have their physical limitations; flexible hose making would otherwise not be such a highly specialized undertaking. It is obvious that no one particular material can be considered a short cut to meeting all operating conditions, so that in hose making it is vitally necessary to make a careful study of all the qualities of the various materials available and to keep closely in touch with all new developments.

A rough guide

The following data, based on years of practical experience, can be taken as a rough guide to the types and potentialities of flexibles today.

Rubber flexibles. Probably the best known of all flexibles, they have varied applications. A molded rubber hose with cotton braid reinforcements can usually be recommended for conveying air, gas and oxy-acetylene at pressures in the region of 250 psi. For heavier duty, a mandrel-wrapped flexible with braided cord reinforcement, should be used. A mandrel-wrapped hose with wrapped ply reinforcement should also be used for steam—there are various grades for up to 120 psi working pressures. For use with acids and other chemicals there are mandrel-wrapped and molded hoses, but the greatest care should be taken when ordering to ensure that the operating temperature and pressure, and also the concentration of the chemical, is fully specified.

Although the range of natural and synthetic rubbers is extremely wide, it is not always possible to use a rubber flexible, as many acids and alkalis in general use tend to neutralize, wash out or otherwise dissolve certain constituent parts of the hose material. This action can cause rapid disintegration of the hose or result, at least, in minute particles of the hose material adulterating the conveyant.

The operating temperature for rubber-based flexibles also restricts their use in some directions. The maximum temperature is in the region of 300 deg. F. after which there is a tendency for the hose to become oxidized and brittle, while at the other end of the scale, in low temperature conditions of approximately minus 20 deg. F, there is an early tendency of brittleness and stiffening which could cause the hose to snap if violently flexed.

Typical applications for rubber flexibles are in compressed air equipment, greasing equipment, hydraulics and lubricating equipment.

Metallic flexibles. With flexible hoses constructed, for example, from metallic strip, there is a distinct advantage over most other materials in relation to the temperature range. It is possible to cater for temperature conditions in the region of 1,100 deg. F, but to achieve a high degree of flexibility comparable with, say, a rubber hose, it is necessary to leave the normal range of interlock metallic and resort to the more expensive seamless metallic hoses. These are produced from solid drawn tubing and formed into a helical or parallel series of corrugations.

An additional advantage with this latter type is that it is less liable to fracture or disintegrate under lateral strain, which, by virtue of its principle of manufacture, is one of the inherent weaknesses in metallic interlock hose. Particular care must be taken, however, not to over-flex or stretch beyond its natural bend radius. Apart from the electrical conduit type of metallic hose construction used for armoring of cable leads, the most common type of metallic flexible hose in use is the interlock strip range of pressure tubing, where, as previously indicated, the degree of flexibility is restricted in

(Continued on page 58)

Have you considered silver brazing?

One of the outstanding attributes of brazing is the flexibility of the method. It produces strong, uniform joints in a large variety of metals

By A. M. Setapen HANDY AND HARMAN

The designer now has a considerable stake in what was once largely the concern of the production engineer—the selection of a joining method. His interest in joining methods is twofold. By a judicious choice of method he can often not only improve the product, but also reduce fabrication and assembly costs and make use of lower-cost structural components.

Because of the increased familiarity with the simplicity and versatility of the process, the number of applications for brazing with silver alloys has become greater in the last 10 years.

One of the outstanding attributes of brazing with silver alloys is the flexibility of the method. It produces strong, uniform joints in a large variety of metals. Assemblies can be designed to use low-cost stampings, die castings and other mass-produced components, as well as parts conventionally machined from solid metal. Also, brazing can be accomplished with silver filler metals, using almost any standard heating method, including the simple hand torch, semiautomatic induction heating and automatic furnaces. This versatility results because the filler metals have a relatively low liquidus temperature (about 1200 to 1300 deg F for most) and so special heating equipment and controlled atmospheres are not required for most applications. In many cases, brazing provides the only economical means of producing assemblies on a mass basis (particularly where large numbers of joints must be made simultaneously) or of joining dissimilar metals.

The American Welding Society has adopted the following definition for brazing: "A group of welding processes wherein coalescence is produced by heating to suitable temperatures above 800 deg F and by using a nonferrous filler metal having a melting point below that of the base metals. The filler metal is distributed between the closely fitted surfaces of the joint by capillary attraction."

This means that in a brazed joint the parent metals themselves do not melt, but are held together by an intervening layer of filler metal.

A standardized system for designating and specifying all types of brazing filler metals by the American Welding Society has recently been compiled. Under this system, the silver filler metals are given BAg classifications (see Table 1).

The silver alloy filler metals may be used for joining any of the ferrous or non-ferrous metals, including iron, steel, stainless steel, nickel, copper, brass, bronze and chromium alloys. The exceptions are aluminum, magnesium and other metals whose melting points are lower than the brazing temperature required for the filler metals. The major constituents of most of these filler metals are silver, copper and zinc; in addition, some contain cadmium, nickel or tin. The compositions of filler metals in this group provide ample opportunity for selecting one which offers the desired properties of liquidus temperature, melting range, wettability with certain metals, ductility and other properties that may be required for a given application. Most of the BAg filler metals are malleable and ductile and are thus available in thin sheet, fine wire, strip, rod and powder. They can be stamped and formed into washers, rings, shims or any special shape required for pre-placement. Color after brazing ranges from white to light yellow.

The strength of the filler metal is only one con-

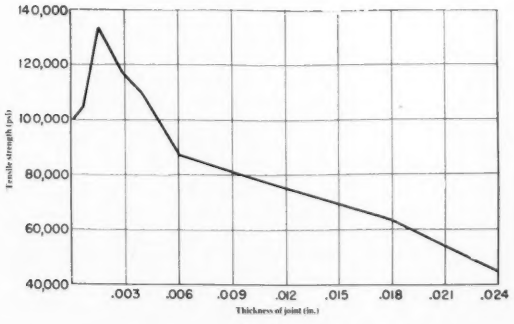


Fig. 1

The effect of thickness of joint on tensile strength.

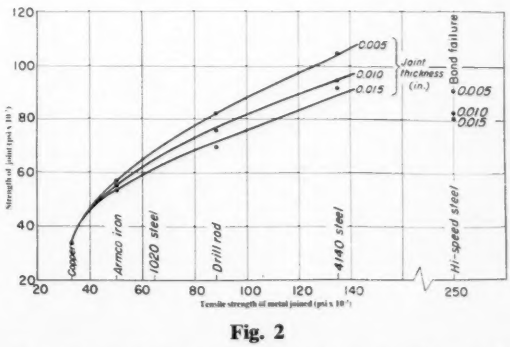


Fig. 2

Relationship of joint tensile strength to metal strength.

Case History: Savings in making a triple sprocket

Much lower material and fabrication costs resulted from assembling this triple sprocket from blanked sheet steel parts instead of machining the parts from the solid. The sprocket is used in the self-propelled farm combines manufactured by Massey-Harris-Ferguson Ltd.

Formerly the two large sprockets were made as a single unit which had to be bored, turned and hobbed from a solid piece of stock. The hub (and integral smaller sprocket) was machined from bar stock slightly larger than the sprocket diameter. The double sprocket was then welded to the hub.

With the more economical method developed, the sets of three sprockets are blanked from ½-in. SAE 1045 steel plate, then bored and hobbed in groups. The hub is still machined, but from smaller diameter stock than could be used before. The three sprockets are then induction brazed to the hub, using a preplaced ring of Easy-Flo silver alloy filler metal at each point. Total assembly and brazing time is about 1¾ minutes for each part, faster than the production rate of a welder.

Silver brazing continued

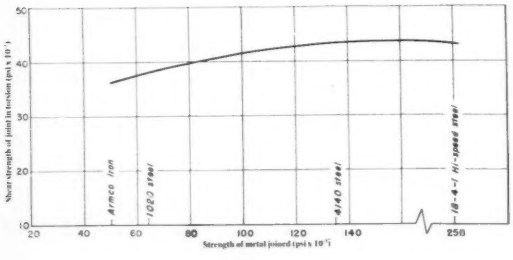


Fig. 3

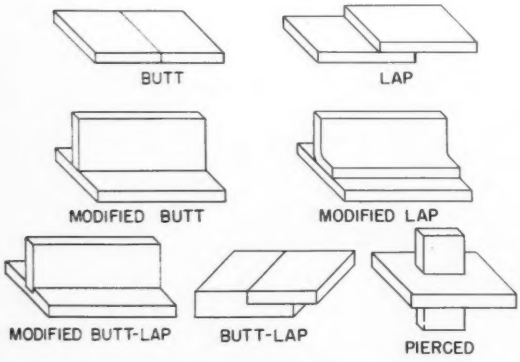
Relationship of joint shear strength to metal strength.

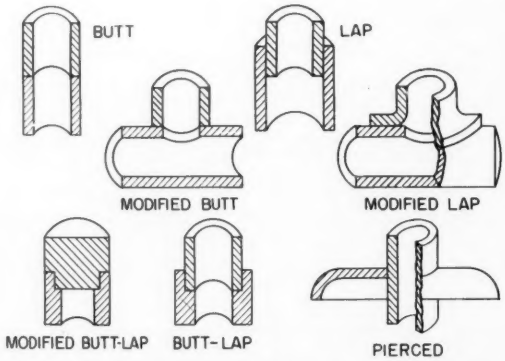
tributing factor to the strength of a brazed joint. This is verified by the fact that, in many cases, joints resist stresses much higher than those capable of rupturing the filler metal itself.

Five major factors influence the strength of brazed joints:

1. **Thickness of the filler metal layer.** There is an optimum range of joint thickness (that is, clearance between members) which provides greatest strength. Outside those limits, joint strength decreases.

Fig 1 is a curve showing the relationship between joint thickness and tensile strength. The data was obtained from joints in stainless steel sheet 0.031 in. x 0.5 in. having an as-received strength of 160,000 psi. Note that maximum strength is obtained with a thickness of 0.0015 in. and that the strength decreases substantially as clearances increase beyond 0.004 or 0.005 in. On soft metals the thickness of joint is relatively less important on the ultimate strength of the joint.





Figs. 4a and 4b. Some of the basic joint designs for flat and curved surfaces. See text for explanation.

Table 1

Filler Metal Classification	Nominal Composition					Temperature (deg. F)		
	Ag	Cu	Zn	Cd	Others	Solidus	Liquidus	Brazing Temperature Range
BAg-1	45	15	16	24	——	1125	1145	1145-1400
BAg-1a	50	15.5	16.5	18	——	1160	1175	1175-1400
BAg-2	35	26	21	18	——	1125	1295	1295-1550
BAg-3	50	15.5	15.5	16	Ni 3	1195	1270	1270-1500
BAg-4	40	30	28	—	Ni 2	1240	1435	1435-1650
BAg-5	45	30	25	—	——	1250	1370	1370-1550
BAg-6	50	34	16	—	——	1270	1425	1425-1600
BAg-7	56	22	17	—	Sn 5	1145	1205	1205-1400
BAg-8	72	28	—	—	——	1435	1435	1435-1650
BAg-9	65	20	15	—	——	1280	1325	1325-1550
BAg-10	70	20	10	—	——	1335	1390	1390-1600
BAg-11	75	22	3	—	——	1365	1450	1450-1650

When do you use these filler-metals?

BAg-1 and BAg-1a are general-purpose filler metals. They have the narrowest melting ranges occurring in this group, are free flowing and low melting.

BAg-2 is also suited to general-purpose work at slightly higher brazing temperatures. It is free flowing. Its wider melting range is helpful where clearances are not uniform.

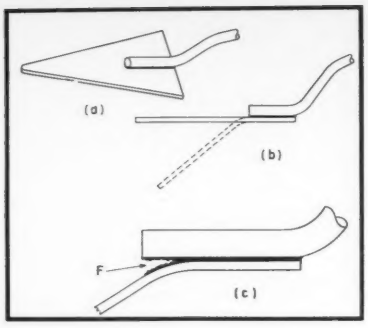
BAg-3 and BAg-4 are both used for joining carbide tool tips to tool shanks and for other applications where the additional wettability provided by the nickel is desired. BAg-3 has a fairly wide melting range making it useful for bridging gaps or forming fillets. It has good corrosion resistance. BAg-4 requires a slightly higher brazing temperature but has the advantage of being more free flowing than BAg-3 when molten.

BAg-5 and BAg-6 are general-purpose filler metals designed for use at higher brazing temperatures. Since they do not contain cadmium, these filler metals may be used for applications in which this element is prohibited or undesirable, as in food handling equipment.

BAg-7 is a general-purpose, low-melting filler metal. It appears to offer advantages in joining stainless steels and some nickel alloys because the lower brazing temperatures required help reduce the occurrence of stress corrosion cracking in the parent metal. It is a good filler metal for furnace brazing and its color after brazing nearly matches the color of stainless steel. Hence it is commonly used in food and dairy equipment where cadmium-free joints are required.

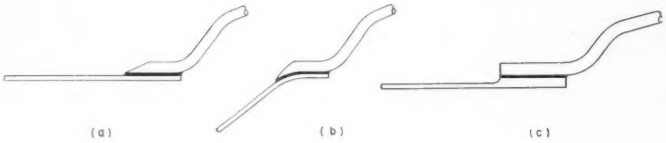
BAg-8 is used where the presence of volatile elements in the filler metal cannot be tolerated, as in the assembly of vacuum tubes. It is free flowing, but does not wet well on ferrous metals.

BAg-9, 10 and 11 are used particularly for joining sterling silver. The three filler metals have appreciably different liquidus temperatures, which make them useful for applications where joints must be made consecutively on the same parts.



Problem—to make a strong lap joint. Solution—bevel the handle.

Figs. 5 and 6. A trowel shows a way of avoiding stress concentration.



2. **Strength of the metals being joined.** In general, the higher the strength and hardness of the metal being joined, the higher the strength of the brazed joint. Usually the upper limit of joint strength is the strength of the parent metals.

Fig. 2 shows the relationship between joint strength and the strength of the parent metals. It illustrates the important point that joint strengths can be obtained well in excess of the maximum tensile strength (approximately 50,000 psi) of the silver alloy filler metal itself.

If the parent materials are stronger than the filler metal, the joint will hold under tension until the yield point of the parent metal is reached, and then the failure will occur in the filler metal. If the parent metals are softer and weaker than the filler metal, failure will occur in them and not in the filler.

Fig. 3 shows the relationship between joint shear strength and strength of parent metal. As may be seen by comparison with fig. 2, the strength of the parent metal is less a factor in the strength of shear joints than in tensile joints. With hard brittle materials, higher shear values may be obtained with thicker joints. Conversely, with soft, ductile materials thin joints may be stronger, but in most cases the differences are small.

The fatigue strength of a material is generally proportional to the tensile strength. Where soft metals (such as low carbon steel or copper) are joined, the fatigue strength of the brazed joint is about the same as the material joined, up to about 27,000 psi. In stronger materials, the layer of brazing metal is relatively softer and the fatigue strength of the stronger material cannot be realized unless the design is such that the fatigue stress in the braze layer is relatively low. In the absence of better information, the stress should preferably not exceed 27,000 psi.

3. **The degree of wetting and bonding between the filler metal and joint members.** The basic requirement for good bonding is that actual alloying takes place between the filler metal and the base material to form a strong inter-facial layer. General purpose alloys and fluxes are compounded to provide good wetting and alloying with most metals. Special filler metals and fluxes are available for the more difficult wettable metals or where special problems of melting point or of high-temperature (or corrosion) service arise. Advice on these matters is readily available from most manufacturers of filler metals.

4. **Freedom from voids and flux inclusions in the joint.** This is simply a matter of adequate cleaning of parts and reasonably careful brazing technique. It is a production (not a design) consideration.

Under most circumstances maximum joint strength for all types of joint will be obtained when each joint face is first "tinned" with the filler metal. Then, at brazing temperature the joint faces are wiped together shear-wise as a means of removing most of the flux from the joint.

Although wiped joints are usually not necessary for most production work, this procedure can be followed to minimize voids and flux inclusions when maximum strength is a critical consideration.

5. **The mechanical characteristics of the assembly and distribution of load stresses in service.** Proper joint design, to prevent stress concentration in one part of the joint, makes an important contribution to joint strength as, for example, if a butt-joint is subjected to bending, one part of the joint carries the greater part of the load. Failure can be expected to start at the point of stress concentration and destroy the joint by progressive tearing.

Similarly, if a relatively soft rod is brazed into a relatively hard sleeve and the joint is subjected to shear stresses, the rod may neck down along the edge of the sleeve and create a radial tensile load, in addition to the shear load at the point. The combination of stresses along the edge will most likely cause failure to occur at a lower load than would cause failure if shear stresses alone were present.

Proper joint design is one of the principal factors in obtaining a strong, serviceable brazed assembly. One of the major considerations in joint design is to prevent concentration of stress at some particular area of the joint. Joints are sometimes designed on the assumption that any discrepancy between the calculated average stress distribution and local concentration of stress in actual service can be compensated for by increasing structural sections by some safety factor. Sometimes this is not a safe assumption, as will be shown in what follows.

Two basic types of joint, lap and butt (or modification of these) are commonly used for brazing with silver filler metals. The joint members may be flat, round, tubular or of irregular cross section. Some of the basic joint designs for flat and curved surfaces are illustrated in figs. 4(a) and (b).

Lap joints. Tensile Stress. A typical lap joint, such as might be used to join the handle to the blade of a trowel, is shown in fig. 5(a). In service, the trowel blade deflects as shown in fig. 5(b). If the joint is made as shown, even a well-made joint will start to peel at point F (fig. 5(c)) because of the tensile stresses. Lengthening the lap will not solve this problem, but will merely provide a longer joint to be torn.

Failure occurs because the handle is a rigid member. As the blade bends, the shear stress concentrates at the point of tangency between the bent blade and the handle. A minor re-design of the handle will alleviate this problem. If the tip of the handle is beveled, as

shown in fig. 6, it will no longer remain rigid as the blade flexes, but will bend with the blade (fig. 6(b)). The stresses are now more uniformly distributed along the handle and the blade and handle almost indestructible.

This example illustrates an important concept in avoiding destructive stress concentration. That is, where a relatively non-rigid member is to be joined to a rigid one, design the rigid part so that the portion of it adjacent to area of stress concentration (usually at the edge of the joint) can follow the deformation of the non-rigid member. Frequently this additional flexibility at the joint can be achieved by judiciously decreasing the thickness of the rigid member. Where it is not desirable to decrease the gauge of the rigid member, a satisfactory alternative is to strengthen (or stiffen) the flexible member so that the point of stress is moved away from the edge of the joint. Fig. 6(c) illustrates this alternative.

Shear Stress. If a series of equally spaced marks are scribed on the side of the layer of filler metal (shown greatly exaggerated in fig. 7(a), the marks will alter direction and spacing (fig. 7(b)) when the two members are subjected to shear. Clearly, the stress is highest at the ends and lowest at the centre of the joint. A further complication is the bending moment created by the offset of the loads. This moment at the ends of the joint introduces a tension stress at the edges of the layer of filler metal and causes peeling of the edge of this layer, in the same manner as fig. 5.

This situation can be remedied by the use of a tapered or scarf joint (figs. 8(a) and 8(b)). From fig. 8(c) it is evident that extreme lengthening of the lap length does little to help the joint to resist shear, since little or none of the shear load is transmitted to the middle of the joint. Scarf joints can be made on round or flat rod, wire, sheet or tubular parts. A common rule is to make the area of the scarf joint two or three times that of the right angle area of the joint face. While a scarf joint has about the same tensile strength as a butt joint of equivalent area, it does have the advantage of distributing combined tension and bending stresses over a relatively large area.

Butt joints. If the joint is fitted carefully and a clearance no greater than 0.003 in. maintained at the finished braze, butt joints will have high strength. They are used where the double metal thickness of a lap joint would be objectionable and a scarf joint is not desired. The edges of joint faces must be cut and fitted square and straight to maintain the uniform, close spacing necessary for a uniform flow of the filler metal throughout the joint area. The typical V-groove used in making but joints by welding is not recommended for brazing, because of the excessive clearance at the wide part of the groove. Such a groove is satisfactory for other joining methods which do not depend on capillary attraction for distributing the filler metal.

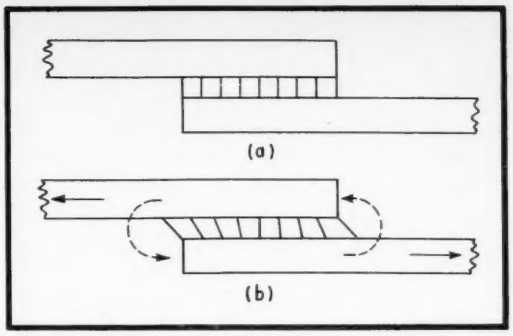


Fig. 7. Filler metal before and after shear stress.

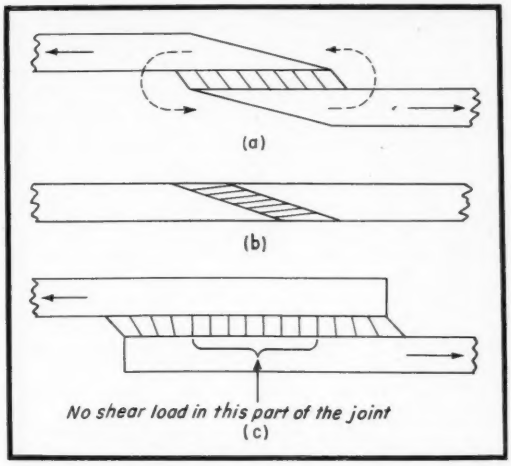
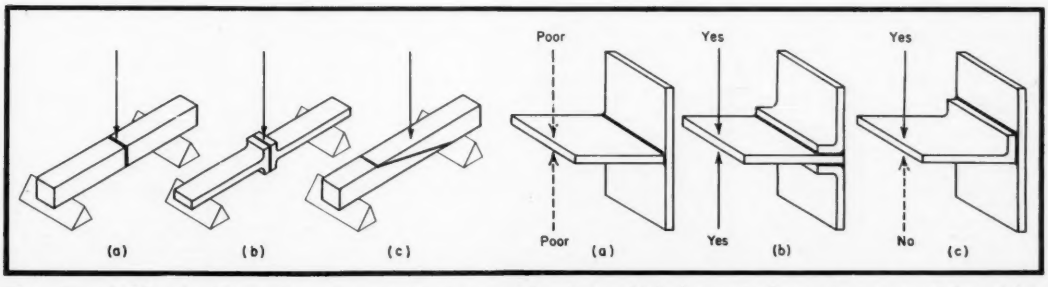


Fig. 8. A tapered or scarf joint provides a remedy.

Impact strength. Some considerations which bear on the performance of butt joints under impact are illustrated in figs. 9 and 10. Again, we must take into account a basic factor in joint strength: the relative strength of the parent metals and the filler metal. If an Izod test specimen is made from two pieces butt joined as in fig. 9(a), the impact strength of the joint will be largely governed by the strength of the parent metals. If the parent metal is relatively soft, the impact will deform the metal so that the largest part of the force is absorbed by the structure and not by the filler metal and the joint will have high impact strength. However, if the parent metal has high strength it will not yield under impact, so that whatever deformation occurs is concentrated in the filler metal. **now see page 51**



Figs. 9 and 10. An illustration of some of the considerations which bear on the performance of butt joints.

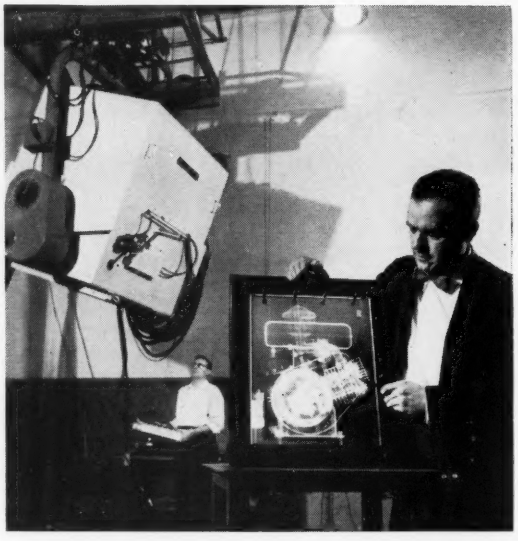
Ideas round-up

X-ray explores the heart of a running engine

Mechanical engineers are, we believe, distinguished by their ability to visualize what is going on inside an engine. Now they will be able to check their ideas with the help of a powerful X-ray machine developed by General Electric in co-operation with the Detroit Arsenal.

This new technique, called stroboradiography, uses rays from a 15-million volt betatron to penetrate right through a running engine. Several thousand "flashes," each synchronized to occur at exactly the same place in the engine cycle, are projected through the engine, to be caught on a single radiograph film. Since each flash takes but 10 millionths of a second, it is possible to build up a clear picture even at high engine speeds. It is, of course, possible to take successive radiographs, spaced at a few degrees of engine rotation apart, to make up a slow-motion moving picture.

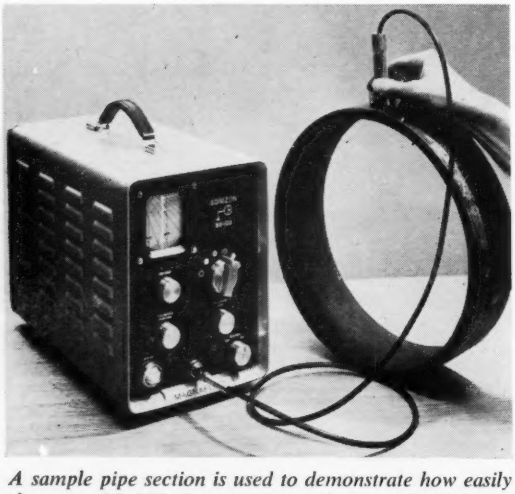
The engineers who worked out this new technique hope that it will afford a useful tool in the unending search for efficiency in engine design. (208)



This equipment has not only allowed engineers to see through steel but stop the action of a running engine.

Unheard sound measures unseen thicknesses

A completely new ultrasonic thickness measuring instrument, the SO-100 Sonizon, has been announced by Magnaflux Corporation. This new instrument reverses present ultrasonic design trends to either big, console-type equipment with visual presentation or to very small portable equipment with audible presentation. The instrument is truly portable—it weighs only 30 lb—and is designed for heavy use in production testing. Thickness readings are by the most rapid and accurate means with a visual cathode tube presentation. An accuracy of ± 1% of thickness is possible.



A sample pipe section is used to demonstrate how easily the new SO-100 Sonizon is used to read thickness.

Its small case, light weight, and 5-ft-long search cable make it suitable for use in constricted areas or where many moves are necessary. Examples are boiler or vessel inspection, aircraft overhaul inspection and preventive maintenance inspection of hollow box-beams. The 3-in. presentation tube has an exceptionally bright and clear trace. Light shields are never needed, even on outdoor work.

Automatic operation

Circuits for completely automatic operation have been built into the Sonizon. In this way, predetermined tolerance limits are imposed on the instrument so that it will automatically actuate "go-no go" equipment or alarms, depending upon the measurement. Production operations such as bonding, making cast iron pipe and wing-skin milling can use this feature to good advantage.

Another feature is the ease with which thicknesses beyond the normal direct reading range (0.500 in.) are measured. A special clipper circuit eliminates hash or noise, equalizes the size of pips and narrows the pip base to a straight line. This results in accuracy in reading multiple harmonic pips. A simple harmonic calculator is included with the unit, for making measurements rapidly, up to 4 in. without calculation. Alternatively, an accessory harmonic comparator can be used to make this an even faster process. With this the direct reading range is increased to 5.0 in. (209)

Two new spring wires come on to the market

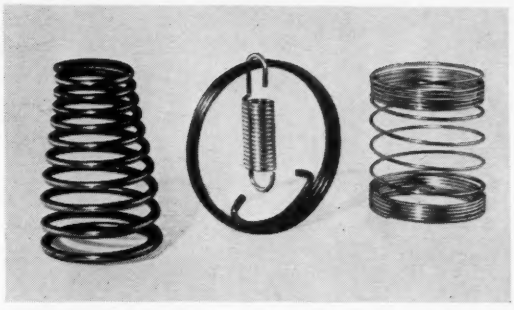
Two new spring wires, with the trade names Trucoat and Micro-Tin, have been put into quantity production by National-Standard Company.

Both were developed to provide the closer dimensional and load tolerances essential in today's precision springs, so necessary in many critical springs intended for two-load applications. In addition, the use of this improved wire on the easier springs results in increased production and a lower rejection rate.

Trucoat wire has a chemically prepared, nonmetallic coating. This results in a wire with lower out-of-round characteristics than conventional music wire. The coating also provides excellent lubrication during coil winding, according to findings during pilot runs involving about 500,000 lb of wire. Down-time for machine adjustment is greatly reduced because of the greater uniformity of the wire.

The coating is light grey in color, so there is very little difference in appearance between springs made from this material (after the stress-relieving heat treatment) and springs made from the usual bright music wire. The coating contrasts sharply with the appearance of oil-tempered wire, so it is easily identified in stock. The coating is easily removed by conventional methods and the springs can therefore be plated without difficulty.

Trucoat is manufactured in all conventional spring wire sizes. It is supplied in standard coils or in extra heavy coils (containing as much as three times the amount of wire). This greatly reduces machine down-time for coil changes.



Manufacture of springs with high index numbers is simplified by two newly marketed types of wire. Darker springs are made of Trucoat wire, lighter of Micro-Tin.

Micro-Tin was developed to meet the need for a more uniform corrosion-resistant music wire for the precision springs used in business machines, electronic gear, appliances and similar applications.

It is available in all conventional spring wire sizes. An improved coating process developed by National-Standard Company almost entirely eliminates lumps and surface irregularities, thus producing a wire that lends itself to the winding of corrosion-resistant springs to more precise limits.

Production runs have indicated that the new wire makes tinned spring production no more difficult than manufacturing conventional bright wire springs. (210)

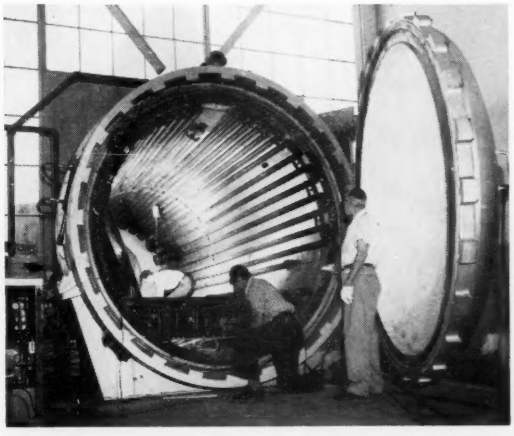
Metal-to-metal bonds cure in a big oven

A vast development in high strength adhesives has taken place since World War II. Prior to this, bonding was generally associated only with methods employed in the manufacture of plywood and other laminated nonmetallic materials. The word is now a common term for the process of joining (with adhesives) metals, solid organic plastics, natural and synthetic rubbers. The efforts of the aircraft industry have contributed greatly to the development of these adhesives to the point where they are used extensively in primary structures.

Designers are constantly searching for means to reduce the weight without sacrificing the strength of modern high speed aircraft. Metal-to-metal bonding is helpful in this respect because it permits a more uniform stress distribution and increases the strength-to-weight ratio.

Most adhesives used in metal bonding processes require heat and pressure to cure the bond. For this reason, autoclaves or hot platten presses are the principal items of equipment used. Of the two, the autoclave was selected by Avro as the primary piece of equipment for their metal bonding shop. It was considered more versatile than the hot platten press, because both contoured and flat work can be handled with a minimum of tooling.

The present installation permits the handling of components 6 ft wide and up to 25 ft long. The vessel has been designed to take up to 200 psi pressure and



The business end of the big autoclave. The 7-ft. diameter tank is 18 ft. long and will handle CF-105 bonds.

450 deg F temperature, although at present the adhesive in use requires only 100 psi and 350 deg F to cure effectively.

The adhesive used is Narmco 4021 Metalbond. This was selected primarily for its high static strength at room temperature and also at 250 deg F. With most

Continued on page 46

These charts take an "A" for accuracy

Results from a recording instrument are useless without good charts

Lloyd P. Merrill TAYLOR INSTRUMENT COMPANIES

It is well known among precision instrument manufacturers that a recording instrument is no better than the chart that is used with it. For this reason, the manufacture of charts for use on recording instruments is an extremely exacting task which includes special handling and techniques with the raw materials (paper and ink), tools (printing plates, presses and so on) and with the design, which must relate properly to the particular instrument with which the chart is to be used.

The characteristics of paper used for printing recording charts are different from those required for other uses of paper and some of the characteristics required for circular charts are different from those required for strip charts. Also, due to the nature of paper, some of the requirements are not compatible with others so that some compromise has to be made.

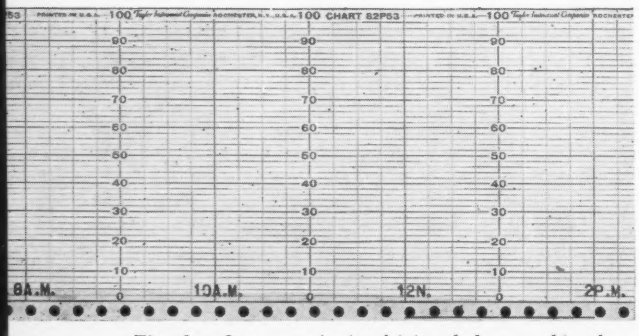


Fig. 1a. One set of pin driving holes on this chart.

These strip charts show two types of driving holes.

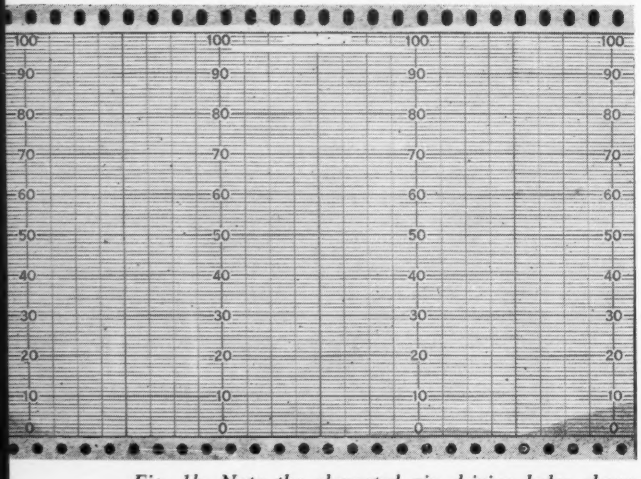


Fig. 1b. Note the elongated pin driving holes above.

Most strip charts are driven either by one set of pins (fig. 1a) or two sets of pins (fig. 1b) driving in holes. In all cases, if there are two sets of holes as in figure 1b one set must be elongated to allow for the expansion and contraction of the paper with changes in humidity. The other set serves as a guide to prevent lateral displacement of the chart, thus controlling the position of the chart with respect to the pen position. If one set of holes was not elongated, the chart would either climb off the pins and not drive correctly, or it would tear or wrinkle with changes in relative humidity.

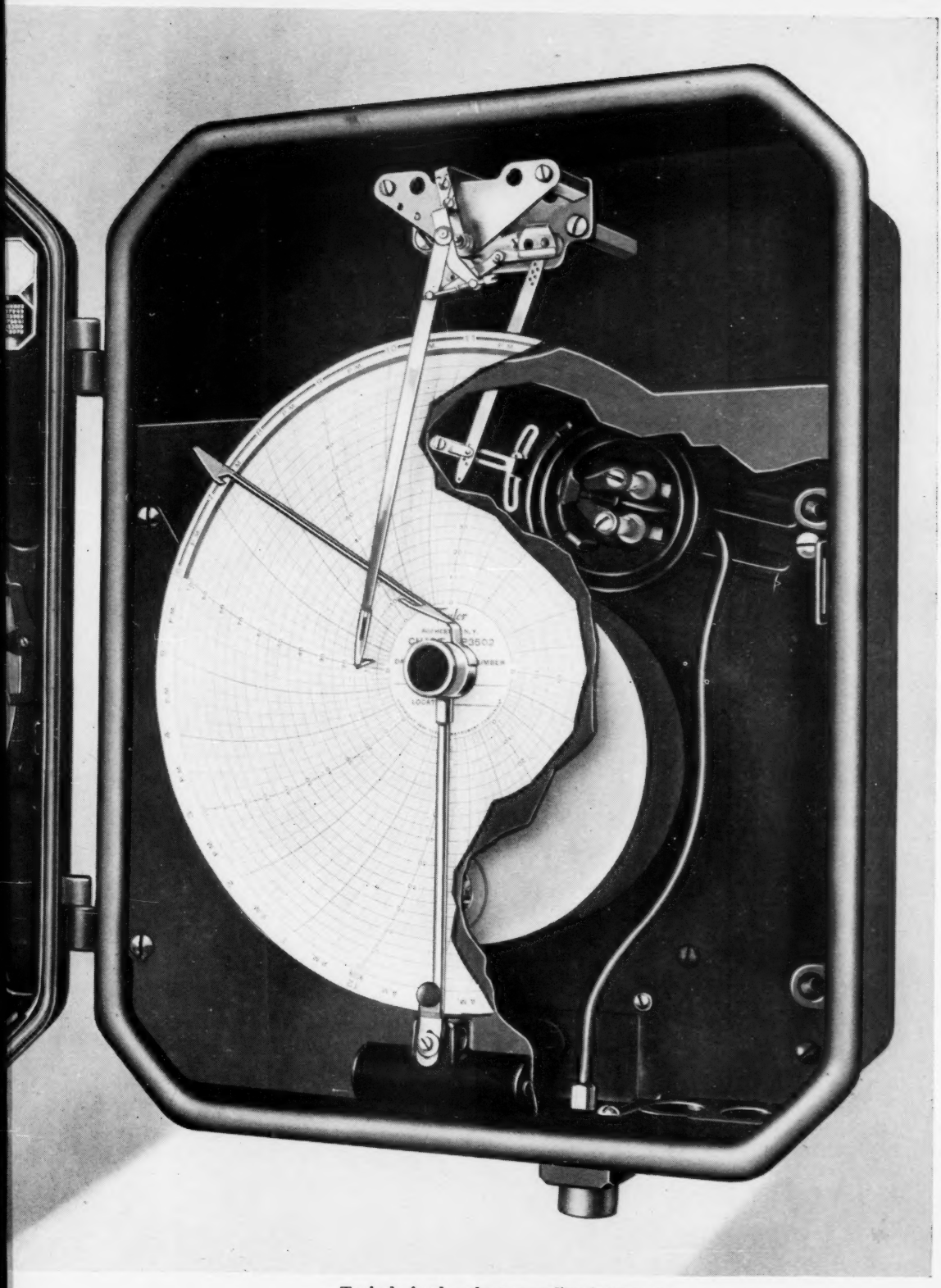
The inking qualities of the paper are also of prime importance. On circular chart instruments, it is desirable to have a recording ink which dries rapidly on a fast rotation chart (such as 12 hours per revolution) and yet not dry in a pen on an instrument with a slower speed chart drive (such as 7 days per revolution). With strip chart recorders, this problem becomes more difficult, since approximately three hours of record shows before the chart is rewound. This means that the ink should dry on the chart in less than three hours and yet not dry in the pen in 31 days—all this without any bleeding or feathering of the ink into the paper.

The stiffness of the paper is of some importance, particularly with circular charts which should not be so flimsy that they are difficult to handle.

Other characteristics, such as smoothness and cutting qualities, are important in the proper printing qualities and handling of the paper in the print shop.

The purpose of a recording instrument is to tell the user what the variations in the measured variable have been, their magnitude and duration. A common type of graph with time as the abscissa and the measured variable (temperature, pressure, flow, liquid level and so forth) as the ordinate is the best way to show this information. The recording instrument, then, is an automatic method of plotting this graph. This graph or recording chart must be designed for the greatest readability and accuracy if it is to serve its purpose. However, it must also be designed to fit the particular instrument with which it will be used.

The ideal and most readily used chart is one with rectilinear co-ordinates or straight time lines. The only way to achieve this is with a strip chart like those shown in figs. 1a and 1b. The chart speed and the time line spacing are selected for the average conditions expected in use. For most industrial processes a strip chart



Typical circular chart recording instrument

speed of 1 in. per hr., with time lines spaced every ¼ in. (or 15 minutes), seems to be most acceptable, although other speeds can be supplied. Also, with a strip chart of this type, the only limit on the length of the chart is the space required for a roll. It is quite common to provide for monthly chart changing on this type of instrument, which means that the chart must be at least 62 ft long. If some chart length is allowed for lead and overrun, 65 ft seems to be a good length for such a chart.

It is impossible to provide a rectilinear chart if the chart is circular. Even if the time lines were straight the time sections would be wedge-shaped with a shorter distance on the chart when the pen is nearer the centre than when it is near the outside of the chart. Actually, to use straight time lines on a circular chart would require quite an elaborate mechanical linkage in the instrument. Fig. 2 shows a typical circular chart recording instrument. Here it can be seen that the pen arm rotates about a centre at the top of the instrument in the middle of the movement. The curved time lines on the chart shown have a radius equal to the length of the pen arm. If these two dimensions differ the pen will not always indicate the correct time.

Probably the most common chart speed for a circular chart is 24 hours per revolution, but chart speeds varying from 1 hour per revolution up to 7 days per revolution are available. On a 24 hour chart the time divisions are usually of 15-minute duration, which means that 96 time lines are required. On 7-day charts, the time divisions are usually of 1-hour duration, giving a total of 168 time lines around the chart.

Chart graduations

The graduations on the chart, which actually tell the value of the variable being measured, are, of course, of the utmost importance. Lines spaced from 0.030 to 0.070 in. apart seem to be the easiest to read. Also, the most easily read and interpreted graduation interval seems to be in units of 0.01, 0.1, 1, 10, 100 or 1,000 times 1, 2, or 5. Hence, knowing the total distance the pen will travel and the range required, the line spacing and graduation interval are selected to fulfill the above requirements. This selection becomes more of a problem if the basic chart layout is to be something other than uniform, such as square root, vapor or altitude.

Uniform graduations are used for the measurement of variables where the primary measuring element gives equal increments of travel for equal increments of the input variable. Examples of this type of measurement are pressure, level and temperature where the primary element is a gas-filled or mercury-filled tube system. The instrument in fig. 2 is a pressure-measuring instrument with a bourdon spring as the primary measuring element. The chart on this instrument is an illustration of a uniform layout.

Charts with square root graduations are used on instruments for measuring flow. Their purpose is to extract the square root of the differential pressure in the flow equation. For example, a brief form of the flow equation is: $Q = C\sqrt{h}$, where Q is the flow, C is a constant depending on such things as the type of orifice and the flow units and h in the differential pressure.

The instrument will measure only this differential pressure but by graduating the chart so that it actually reads the square root of the differential pressure, it gives an automatic computation of the flow. For example, on the 0 to 10 square root chart shown in fig. 3, the chart reading is equivalent to the square root of the differential pressure as follows:

% Differential Pressure	Square Root Chart Reading	Flow Percent
0	0	0
25	5	50
49	7	70
81	9	90
100	10	100

Note that in this non-uniform chart it has been possible to keep to the graduation interval of 1, 2 or 5 mentioned before. Actually to obtain the flow in the desired units from this chart might require a constant multiplying factor which would incorporate the factors covered in the constant (C) in the equation. To avoid so many special chart layouts, a multiplier is quite useful.

Temperature charts

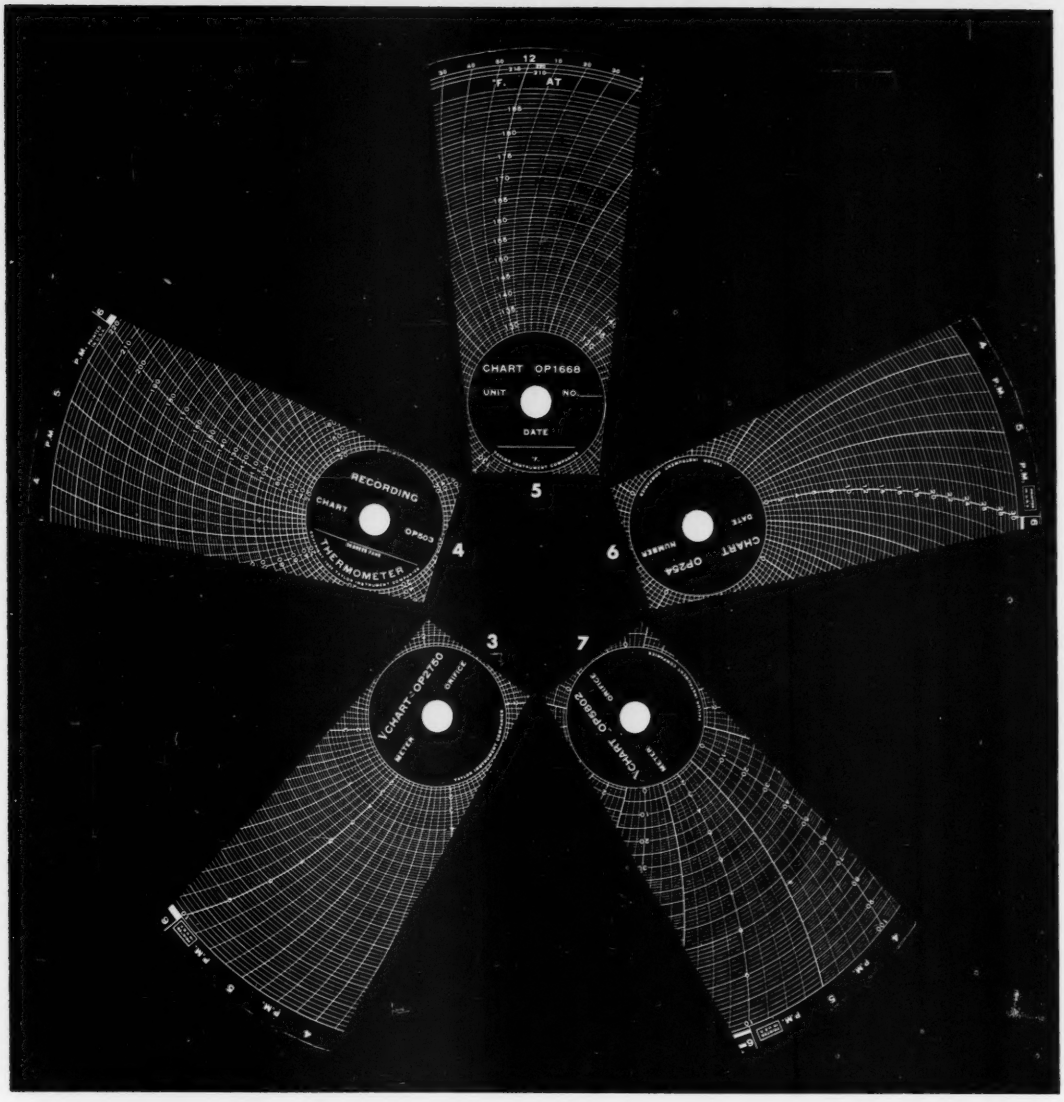
On some temperature measurement applications, it is desirable to record low temperatures but also to have greater accuracy and greater readability at the high temperatures. In this case, a tube-system type of instrument can be filled with any of several vapors. When this is done, it is necessary to use a non-uniform chart where the spacing between the graduations follows the vapor pressure curve of the particular liquid being used. Such a chart is illustrated in fig. 4.

In the dairy industry, legal requirements specify a line spacing of at least 1/16 in. at the pasteurization temperature of 161 deg F. To cover the desired range on the chart then requires a vapor chart as discussed above. However, in addition to this it is sometimes desired to clean the lines with steam at 220 deg F. With a standard vapor chart it would be impossible to record a temperature this high in the space required. To meet this condition the bourdon spring takeoff is built so that at some desired point, say 189 deg F, it hits a cantilever spring which will slow down the motion to this takeoff. In this way the pen travel is limited above 189 deg F and it becomes possible to record the higher sterilization temperatures, although not so accurately. Such a chart is known as a retard chart, because the pen travel is retarded, and a sample is shown in fig. 5.

All these chart layouts may be modified somewhat from the actual theoretical layouts, by linkage non-linearities which may be inherent in the instrument for which they are designed. This is one reason why it is important to use the instrument manufacturer's own chart since he is the only one who knows these factors.

There are many combinations of charts which can be provided for use on multiple pen instruments. For example, a double range chart (fig. 6) may have two separate sets of figures printed on the same chart layout for the measurement of two different variables, such as temperature and pressure. Alternate section charts are available for the same use where one of the variables may be static pressure on a flow job (requiring a uniform layout) and the other variable may be the flow itself (square root). Such a chart is shown in fig. 7.

The basic tool used in printing charts is the printing plate. The most accurate known means of manufacturing a chart printing plate is the wax-engraving process.



Composite of five different types of recording charts

Figs. 3-7. This diagram effectively illustrates the wide variety in charts. All are explained in the text.

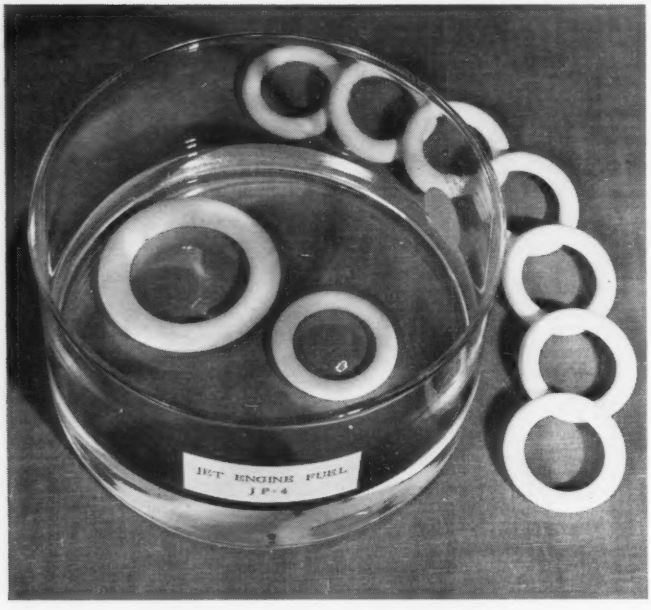
Photoengraving processes are not suitable for the making of chart printing plates. Distortion due to camera lens and the alignment of the negative with the positive whose picture is being taken, as well as the handling of the wet negative, is sufficient to throw the graduations out of round. If errors introduced in this way are added to those introduced due to dimensional instability of inferior paper, the total error of the chart may become quite large.

In the case of circular charts, the concentricity of the centre hole with the graduations is extremely important. If this centre hole is eccentric, further errors may be introduced. The only way to be sure of this concentricity is to punch out the centre hole at the time the chart is printed. In the same way, the alignment and location of the holes in a strip chart is important.

In this article, coverage has been given to the most important considerations basically necessary in the production of accurate charts for recording all the basic variables encountered in the various process industries.

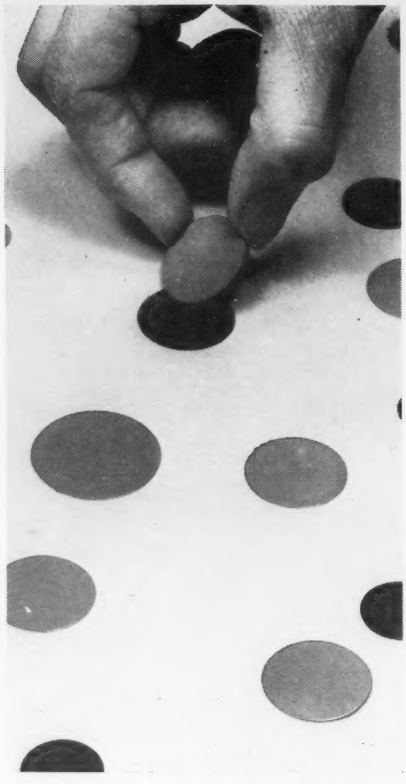
Obviously, neither space nor policy will permit a complete discussion of all the problems and their solutions which have been worked out in the past century to safeguard the inherent accuracy of Taylor charts. ★

Design news in pictures



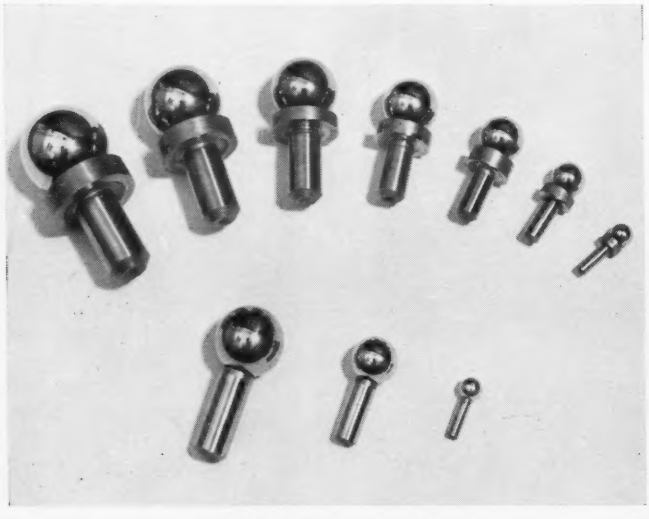
Ring that stays the way it was made

Showing its ability to stay down to size is this O-ring of Silastic LS-53. After 24 hours of immersion in JP-4 jet engine fuel, a conventional silicone rubber O-ring has swelled to over double its original size while the same O-ring of Silastic is unchanged. (200)



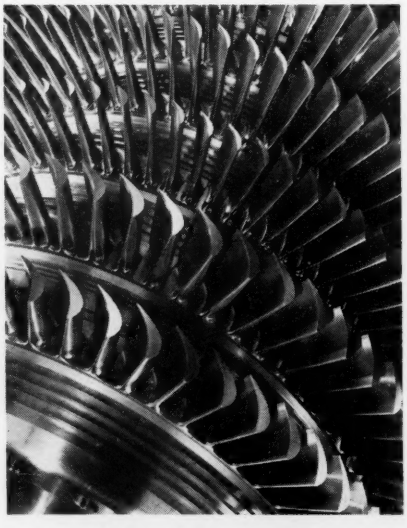
Polka dots go underfoot

A vinyl floor tile known as "Polka-tile" is now on the production line. It is produced by stamping holes in a solid coloured tile. You then add dots to taste. (201)



Tooling balls on parade

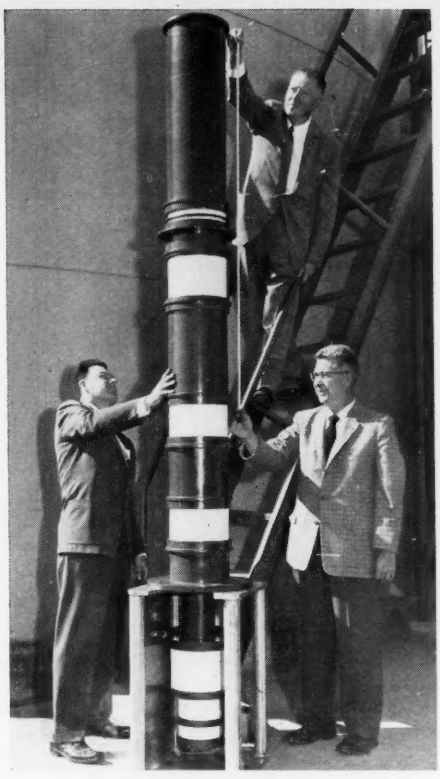
These precision ball devices (made by Industrial Tectonics Inc.) are used as reference points during the construction and subsequent checking of gauges, fixtures, tools and the like. Balls and shanks are attached to each other by electronic welding. (202)



20th century porcupine

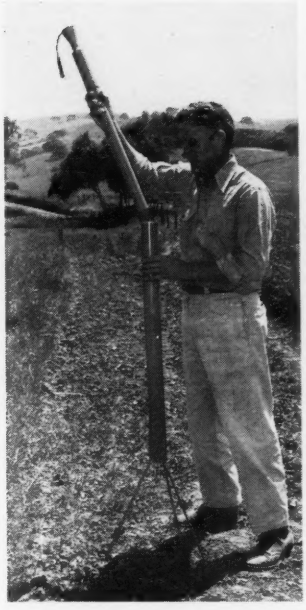
Catching our editor's eye recently was this striking picture of rotor blading in a gas turbine. Photo was supplied by Sulzer Bros. of Winterthur, Switzerland. (203)

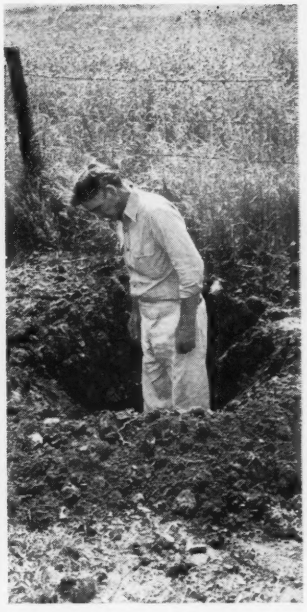
Some modern designs making news today



Another "world's largest"

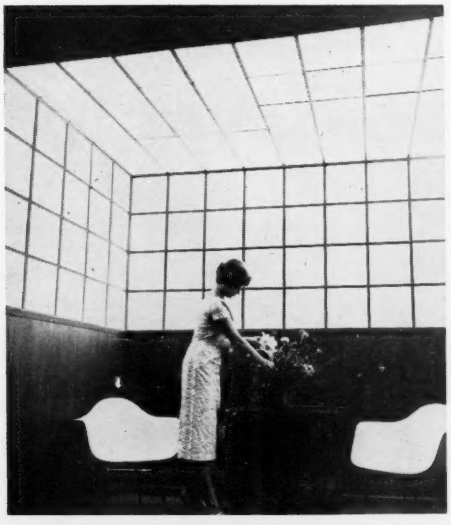
Proudly posed around the world's largest electron tube, top men from Eitel-McCullough (manufacturers) and Ahearn and Soper (Canadian representatives) measure up. (204)





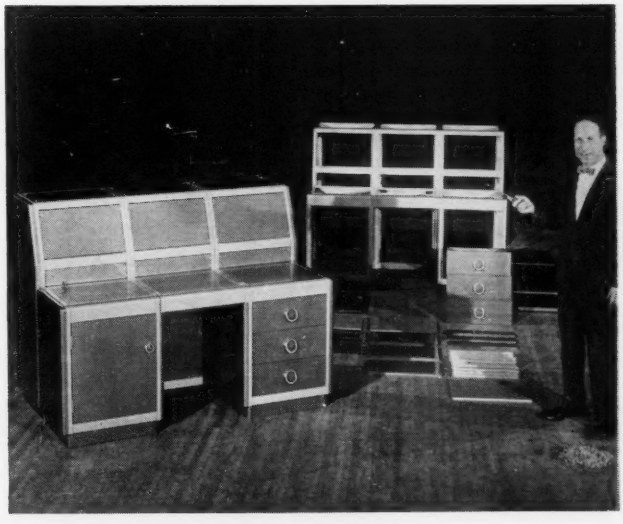
New way to dig a foxhole—fast

In just 1½ min. this digger has a foxhole dug down four feet. Developed by SRI's Poulter Laboratories, it works this way: A rocket, held in a stand, drives into the hard ground. After a 15-second delay the head explodes and the foxhole is dug. (205)



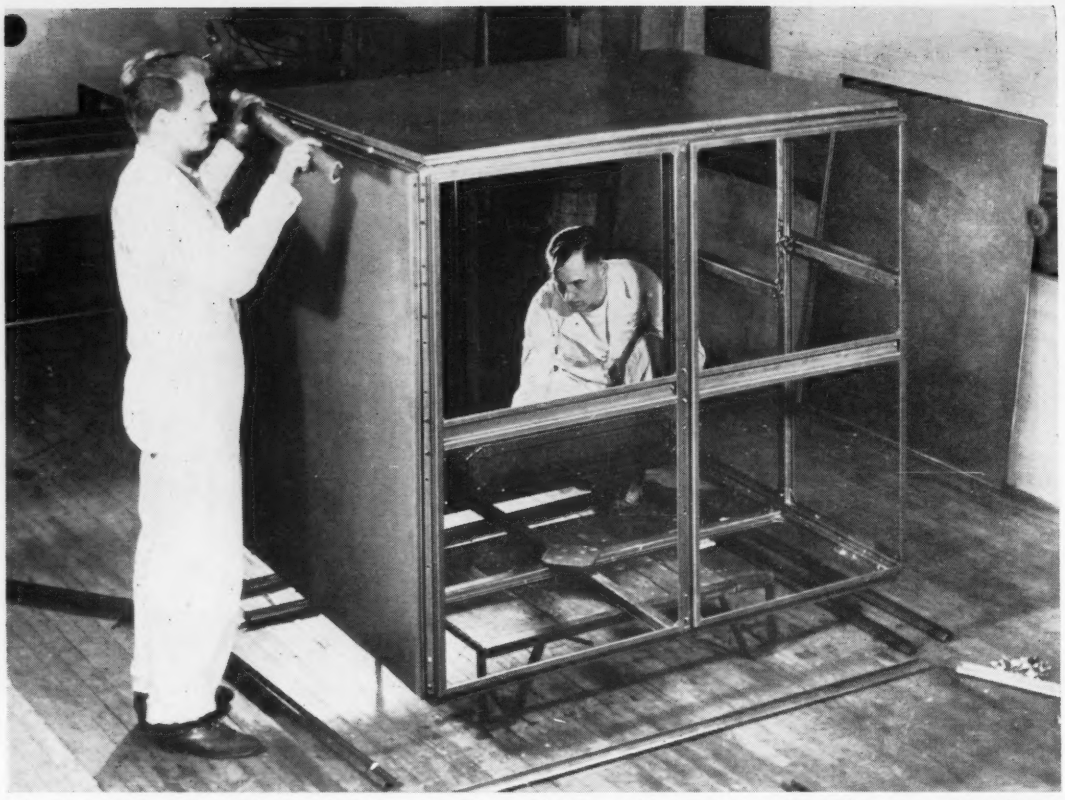
Light from "all over"

Your interest here should centre on the walls and ceiling. Panels no thicker than window glass line this room, providing light from Westinghouse's light source, electroluminescence. (206)



Do it yourself?

A mass-produced modular enclosure system, made by Elgin Metalformers Corp., offers industry a wide variety of cabinets that can be constructed from standard components. Shown in our picture is the 'after and before' of a combination console. (207)



The time required for design, production and delivery of these units was two weeks. They are radar cabinets.

Fast way to build a strong enclosure

By John Dennis ASSISTANT EDITOR

When your production run doesn't justify elaborate tooling, and speed and the use of unskilled labor become paramount, these structures can speak in voices that are loud and persuasive

Most prized and most used item in the toybox of any mechanically minded child is his construction set and reasons for his preference are not hard to find. Shape, size and type of structure he can erect are almost endless—constructions can be run up by virtually unskilled hands — although of a permanent type they can be quickly knocked down to original parts for reassembly and can be enlarged, cut down or altered as the child engineer sees fit.

Related structures, anything but a child's toy, are available to industry from Lindsay-Wilson Ltd. and offer identical advantages.

These structures are an efficient method of holding light gauge sheets under uniform tension all around their perimeter to build up enclosures of any size. Continuous and equal gripping of an entire sheet eliminates the weakness found in some other structures where rivets or welds do the holding.

Diagonals, gussets and struts are unnecessary and yet the resulting panels are extremely rigid and cannot "work" or loosen.

There are basically three components in the make-up of a Lindsay structure—namely panels, framing and fittings. Framing pieces are in the form of hat-shaped channels into which U-shaped channels are bolted. The latter pull the sheets taut as they tighten down into the former (see illustration).

Framing members are from 5 in. to 12 ft. long and

tensioner screw holes are punched at 6 in. to 12 in. intervals. All are of ⅛-in. stock and rolled (extruded in the case of aluminum and magnesium) to standard dimensions.

Panel sheets are usually made from 24 to 20 gauge mild steel in sizes ranging from 5 in. to 143 in. long and from 5 in. to 47 in. wide. Although other gauges could be used, these are found to give the best strength-to-weight ratio.

Fittings are used to connect intersecting flanged channels and come in a variety of shapes designed for their specific tasks. All are die drawn of 16 gauge mild steel. The duty of these fittings is to form connections only and they carry very little stress. Many of them are embossed for added rigidity.

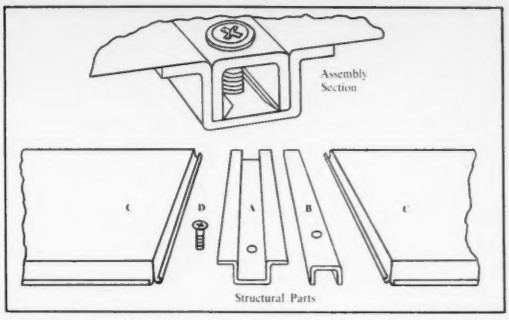
Corner construction depends on the application of the finished product. Corners of 1½ in. radius are used for cabinets and smaller housings. Cove panels, framing and spreaders can be supplied to produce corners of 6 in. or 12 in. radius. These are mostly used on truck and trailer bodies where a streamlined appearance is important.

Applications of the Lindsay structure are extremely wide. Cabinets, housings, buildings, truck bodies and instrument panels are the most obvious.

An eloquent example of the all-around savings that these structures can often make is a refrigerator building designed for the tropics. The building had to maintain subzero temperatures in humid 130 deg. weather.

Specifications were submitted for a Lindsay structure building and one of another type. First good mark came for the Lindsay building when it was found that it required only 1,558 cu. ft. of shipping space as against 2,206 cu. ft.

Weight-wise it scored again. Shipping weight of the second type of building was 64,000 lb. whereas the Lindsay structure building weighed only 25,770 lb.—another considerable saving. That was just the beginning. When the question of manhours required for erection came up, the Lindsay building needed 464 manhours of unskilled labor. The second building required 959 manhours and the labor would have to be partially skilled. As a final dividend the completed Lindsay structure offered an extra 184 cu. ft. of food storage space.



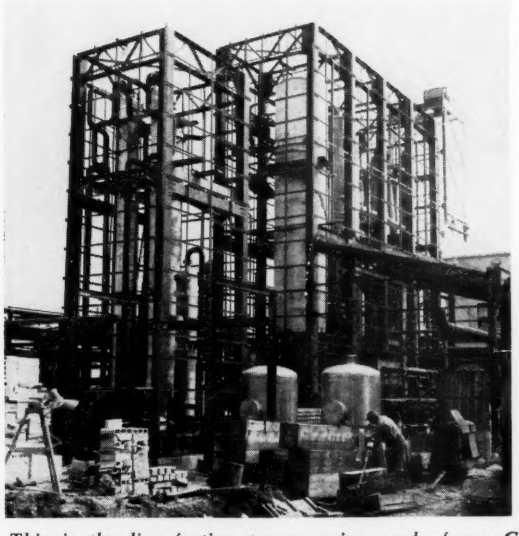
Here lies the simplicity of the basic Lindsay components. A unit is shown assembled and knocked down.

The "before and after" pictures illustrating this article show the clad and unclad state of a liquefaction tower installed at Mill Haven in Ontario for CIL. A further advantage of the structure is apparent here. Elaborate inspection casings and service doorways are unnecessary—any sheet on the structure can be pulled and replaced with ease and no strength is lost.

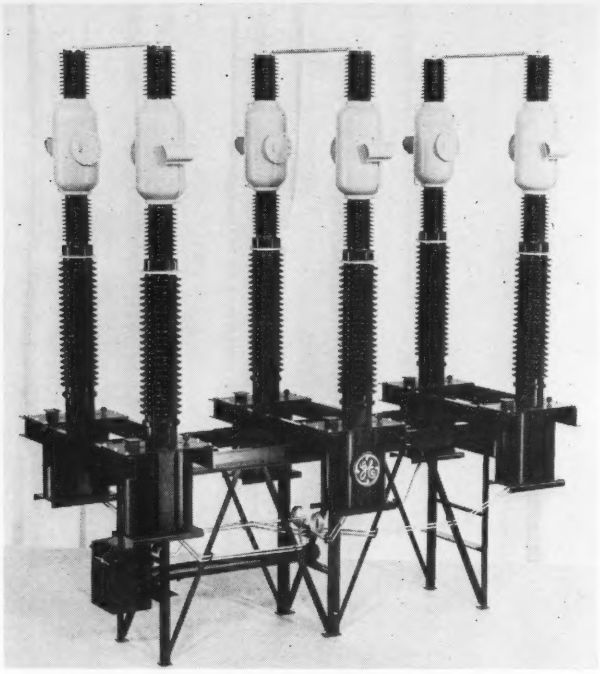
The elimination of drumming in the panels when the structure is subjected to vibration is done by cementing strips of ⅛-in. felt to the spreaders before applying the sheets. Waterproofing can be carried out with an ordinary caulking compound run into the crevices.

Lindsay has developed structural components here that are simple to assemble and easy to change. When the production run doesn't justify elaborate tooling and speed and the use of unskilled labor are paramount, these structures speak up in voices loud and persuasive.★

Shape, size and type of structure that can be built are almost endless



This is the liquefaction tower casing made for a CIL installation at Mill Haven, Ontario. Built by Girdler Corp. of Canada Ltd. to a design by L'Air Liquide of Montreal, the "after" picture reveals a neat structure.



A one-eighth scale model of CGE's air blast circuit breaker.

Birth of a new circuit breaker design

Circuit-breaker designers make a really advanced piece of equipment

When designing a new piece of apparatus the logical place to start is where the latest developments left off. With this principle in mind and an air-blast circuit breaker to design, engineers set to work at CGE some time ago to make a really advanced piece of equipment.

The result of their work is now available as the G-E Air-Blast Circuit Breaker designed for all ratings, 115 kv and up.

What are the features of this new design for which the company claims lower first cost, lower installation expense, reduced weight and maintenance and improved system stability?

Capacitor potential grading devices
In order to maintain even voltage distribution across each of the breaks in the two-break interrupter, capacitors are connected between the interrupter tank and each of the terminals. This effectively connects each of the capacitors across each of the breaks.

Interrupter tank
The interrupter tank contains the air necessary to operate the interrupter mechanism, permitting two complete "close-open" operations without compressor assistance.

Two-break interrupters
The breaker uses two symmetrically opposed contacts in the interrupter so that stresses set up by the moving components cancel out. All the surfaces subjected to arcing are tipped with an arc-resistant sintered material formed from copper or silver tungsten carbide. The operating mechanism and the moving contacts can be conventiently removed through the manhole for maintenance. All units are jig assembled so as to be interchangeable.

The interrupting time for the breaker is 3 cycles with a reclosing time of 20 cycles.

Centre clamped porcelains
All porcelain components are of the one piece wet type. The porcelains are mounted with a centre clamping feature so that all sections of the porcelain are always in compression.

Co-axial conductors
A copper tube runs centrally through the current transformer bushing and is flanged into a split at its lower end. An insulated conductor runs co-axially through the copper tube and is connected to the lower end of the copper tube, in such a way as to form a high voltage loop.

Grounded aluminum envelope
A grounded shield surrounds the high voltage loop, isolating the high voltage conductors from the current transformer core and secondary windings.

Current transformer cores and secondaries
Up to a maximum of four cores complete with multi-ratio secondary windings can be provided.

TINNERMAN

Creating Fasteners for Industry

An idea is born — and a problem solved

That's what is happening constantly at the Hamilton plant of Dominion Fasteners Limited, Canadian manufacturers of the famous line of SPEED NUT brand spring tension fasteners.

Through a combination of creative personnel and up-to-date facilities, this completely integrated Canadian company is able to create, develop and produce improved fastening methods for Canadian manufacturers. Whether you make automobiles or stoves . . . or any product that requires a fastening operation . . . there are greater profits for you with the SPEED NUT system of fastening.

The flat-type Speed Nut from which has grown a family of over 6000 types and sizes of spring tension fasteners.

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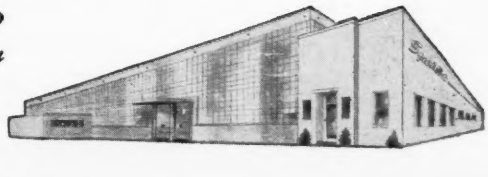

other adhesives the strength falls off rapidly at 200 deg F.

Some indication of the high strength which can be achieved with this material in bonding aluminum-to-aluminum is shown in this extract from the Process specification:

"The average room temperature shear strength of the four test pieces shall not be less than 4,000 psi, with no individual test piece failing at less than 3,700 psi.

"The minimum elevated temperature shear strength (250 deg F ± 5 deg F for ½ hr) shall not be less than 1,500 psi.

"The minimum peel strength shall not be less than 50 lb."

At the present time, bonded assemblies cannot be examined satisfactorily for complete adhesion without some destruction occurring to the bond. To achieve consistently high results, therefore, requires close control of the whole bonding process.

Briefly this process for aluminum alloys is as follows:

1. Prefit parts to ensure correct assembly. Parts must come together with no more than light finger pressure.
2. Degrease with trichlorethylene.
3. Chemical clean, sulphuric acid, sodium dichromate dip.
4. Water rinse. Parts must indicate no water break.
5. Oven dry at 180 deg F.
6. Prime coat the faying surfaces with adhesive.
7. Air dry one hour at room temperature.
8. Oven dry. (10 min at 180 deg F.)
9. Lay up assembly with layer of adhesive film between faying surfaces.
10. Hot tack or rivet assembly (to locate parts).
11. Load in vacuum bag together with thermocouples and test pieces and seal bag.
12. Check vacuum bag for leaks (for clamping of parts).
13. Load bag in autoclave and connect vacuum line and thermocouples.
14. Close autoclave door and commence cure cycle.
15. Open autoclave door and remove bag at end of cure cycle.

As previously stated, this procedure outlines very briefly the stages for an aluminum alloy assembly. Other materials are handled in a similar manner, the differences occurring mainly in the cleaning technique. Throughout the process, cleanliness is of prime importance.

This pilot plant, originally built for experimental purposes has been turning out small bonded assemblies for production. A vinyl wrapped assembly is inserted.

After degreasing (and until they are finally cured), parts must not be touched with the bare hand. It is mandatory that all operators handling these parts wear lintfree cotton gloves, which must be changed frequently.

Test pieces for shear and peel tests are inserted with each batch of parts. Results from these tests must be acceptable before the parts can be passed. In addition, sample parts can be selected at the inspector's discretion for further testing.

Special curing molds and bonding fixtures have been kept to a minimum. The majority of both contoured and flat work is cured using a simple vacuum bag technique. The parts to be cured are placed in a polyvinyl alcohol bag and fibre glass cloth and felt are used as separators and fillers.

The bag is exhausted by vacuum pump and checked for leaks before insertion in the autoclave. The vacuum pressure is also maintained throughout the curing cycle.

As a further quality control check, thermocouples are attached to the parts before they are loaded into the bags. These record as closely as possible the actual cure temperature at the glue line.

A smaller pilot autoclave has been employed on production bonding for several months. This machine was designed so that personnel in the bonding shop could familiarize themselves with the whole bonding operation prior to installation of the main piece of equipment.

So far this has resulted in consistently successful production bonding of aluminum-to-aluminum. Similarly, good bonds have been achieved on production tests with aluminum-to-titanium, titanium-to-titanium. (211)

A new valve-in-head engine for general applications

A new valve-in-head, compact four-cylinder, V-type engine, designed for all general applications in the industrial, agricultural and construction fields was announced today by Lycoming Division, Avco Manufacturing Corporation.

Known as model CV4-180, the engine delivers 70 hp at 3,000 rpm. It is the first air-cooled engine to meet this industrial field challenge.

Its ruggedness and smooth operating performances have been demonstrated both in the field and through laboratory and dynamometer testing.

The engine features the established design and interchangeability of major component parts shown by its counterpart, the C2-90 model 30-hp engine, such as the aluminum cylinder head of valve-in-head design, cylinder barrels, pistons, forged connecting rods, bearings and valves. A full pressure lubricating system employed.

A four-throw, three-main bearing, dynamically counterbalanced crankshaft and twin three-bearing cam-

Continued on page 48

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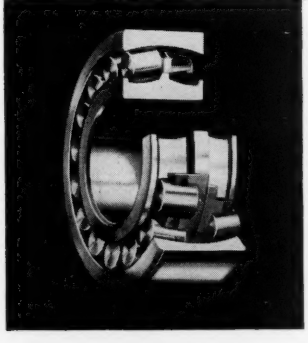

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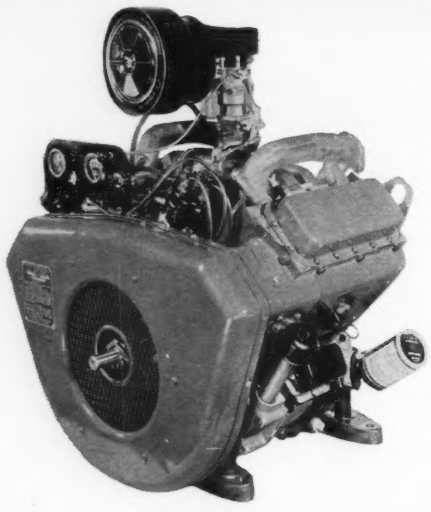


General specifications of Model CV4-180:

Type	Vee type, air cooled
Cylinders	4
Bore and Stroke	4 in. x 3½ in.
Stroke cycle	Four
Firing order—even	1-4-2-3
Speed range at full load, rpm	1,200-3,000
Maximum power and speed	70 hp at 3,000 rpm
Compression ratio	6 to 1
Displacement	176 cu. in.

Weights and dimensions (dry):

Engine (without housing)	463 lb.
Engine (with housing)	545 lb.
Length	28 in.
Width	27.68 in.
Height (without air cleaner)	28.57 in.
Shaft centre to base	10⅝ in.

shafts are included in the engine design. All engine accessories are flange mounted and gear driven.

The CV4-180 weighs approximately 463 lb without the electric starter, generator and flywheel housing, which are offered as optional equipment. The engine power end will be offered with SAE #3, 4 and 5 bell housings as with special pump adaptors and shaft extensions to suit customer requirements. Simplified engine design makes for easy installation and servicing.

The engine is the second in a series of the "full power" industrial family. Future plans include expansion of the line to meet the growing demand for air-cooled engines of maximum performance with minimum maintenance over a wide temperature range. (212)

Furnace that handles small melts of steel

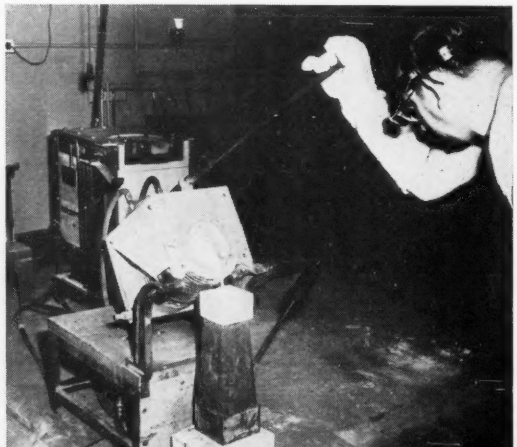
An electric melting furnace for use in the development of experimental tubing analyses is in operation at Superior Tube Company.

Used as a research tool, the 50-lb furnace melts alloys to specifications submitted either by the customer or by the company's own technical department. The small cast billets are then turned, drilled and cold drawn into small diameter tubing for the evaluation of physical, mechanical and chemical properties.

The experimental melts from the furnace are used for developing new cathode materials, such as the Cathaloys. These are contributing to the improvement of cathode materials, to provide vacuum tube cathodes with high strength, long life, freedom from sublimation effects and absence of interface impedance.

In the development of experimental tubing analyses, the new facility saves valuable time by making it possible for the firm to produce immediately its own raw stock without waiting for supplies from outside.

Superior is constantly searching for new materials for its line of precision drawn small tubing. Currently it offers 63 standard and 58 special analyses in carbon, alloy and stainless steels, nickel and nickel alloys, titanium, zirconium and zirconium alloys, copper and copper-base alloys and glass sealing alloys. (213)



Small melts of metals and alloys for drawing into experimental tubings are quickly made up in the furnace.

Continued on page 50

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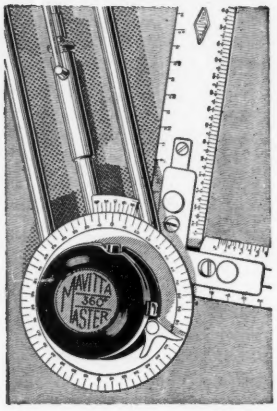

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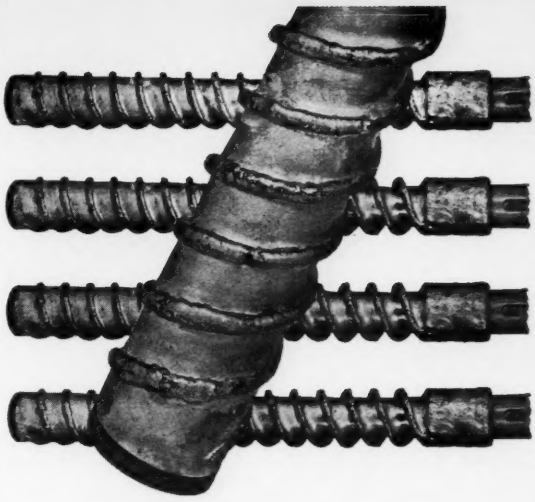
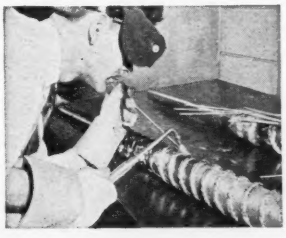


Colmonoy INCREASES Extrusion Screw Life

Tests revealed a tremendous increase in the service life of these Colmonoy hard-faced extrusion screws, as against the unprotected screws usually used. Orders for new replacements now specify Colmonoy hard-facing.

Used for extruding plastic, these screws are made of age-hardening nickel-base alloy. This alloy is now readily hard-faced with little loss of hardness, using Colmonoy No. 6 gas rod and a new Colmonoy high temperature flux.



The 60-inch screws have a .050" overlay of Colmonoy No. 6 when finish ground. Colmonoy hard-facing pays for itself in increased life very quickly on expensive parts such as these.

To provide any metal part with longer life, investigate Colmonoy alloys and methods. They represent a complete line of wear resistant alloys and the most up-to-date in hard-facing techniques.

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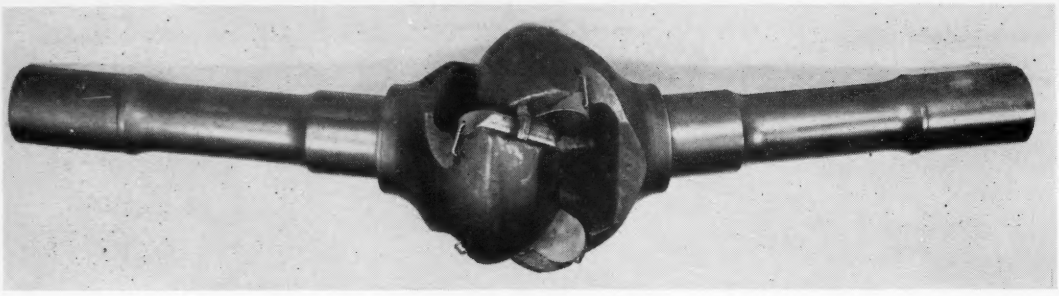

Constant velocity in a universal joint

Most universal joints used today are variations of the Hooke's joint. This is basically a fork or U-shaped member attached to each shaft, and pivoted at the ends of the forks to a cruciform or square connecting member, so that the forks are attached at right angles to one other and in the same plane.

The angle through which such joints can work reasonably well is limited, 25 deg on either side of the fixed axis being the generally recognized top figure.

The main disadvantage for many applications is its inability to transmit uniform motion for the input of one shaft is not exactly reproduced at the output shaft, in terms of velocity.

Velocity variation

The total number of revolutions per minute is the same for both shafts, but at certain stages in each revolution, the driven shaft turns faster (or slower) than the driver.

This velocity variation can be avoided if the driving and driven shafts are connected by an intermediate member, with a universal joint at each end.

Other factors must, however, be considered to enable this arrangement to function properly. The angles made both by the driver and driven shaft axis with the intermediate axis must be identical.

When constant velocity is required from a Hooke's joint, it is obvious from the foregoing that at least two joints must be used, and if a complete unit is required, arrangements must be provided for automatically moving the intermediate component axis to bring about the similarity of the angles made by the driver and driven shafts.

Any axial extension with this type of joint must be made by a splined sleeve or similar arrangement and the angle compensating device must either have running contact with its associated shafts or have external support. It is not a self-supporting arrangement.

The new Garrington joint does not suffer from these disadvantages. Designed with rocking pads, the flat faces of which are constantly on right-angled planes, the contact areas are in identical positions on both the driving member and the driven member at all angles of its coverage. In other words, the driven member pressure areas are a mirror image of the driving areas. It is a truly constant-velocity joint. The fact that the joint faces are at right angles to one another along the axis of the joint, means that there is no axial load; the joint can move within reason, in and out of mesh under power, and it is self-supporting.

It consists of two main members only and needs no intermediate component. The generous pad areas are so designed as to reduce the loading and the main loads are compressive.

Where two joints are used in tandem, as for two parallel shafts not on the same axis, the relationship of the joints to one another is unimportant and the angle that can be covered is approximately 35 deg in each joint. (214)

Monitor of the air we breathe

A new instrument for measuring air pollution, designed and made in England, is attracting considerable interest in government and municipal circles in Canada and the United States, where the problem of smog is reaching serious proportions.

The device, known as the Fleming automatic air pollution recorder, provides a continuous monitoring. By this means, the proper remedial measures to remove foreign air particles at their source can be chosen.

Samples of air may be taken every 12 hours, every 8 hours or even every hour (or less), but there is one overriding condition: There must be a break of about five minutes between consecutive samples.

At predetermined intervals a fresh portion of filter paper is placed in the stream being sampled. An accurately measured quantity of 5 cu ft of air passes through the machine and the filter paper. In order that each day's samples may be identified, a time mark is automatically made on the filter strip.

The strip of filter paper, with its sample, can be removed from the machine and the degree of contamination determined by various methods, such as comparing the difference in the light transmitted through a sample and an unused filter or by chamical analysis, if so desired.

It is possible to modify the device to meet individual

Continued on page 52

Silver brazing

(Continued from page 33)

To increase the impact strength of a butt joint of a hard parent metal, the measures illustrated in figs. 9(b) and (c) will be effective. In the former, the thickness of the specimen has been decreased without reducing the joint area. This increases impact strength for, owing to flexibility of the thinned-down metal, the structure can deform and thus absorb impact. The scarf joint, which can be considered as a modification of the butt joint (fig. 9(c)), will also have a higher impact strength, because the joint intersects the surface at a point removed from the location of a maximum bending moment (the centre). Actually, if the scarf is made long enough, the mode of failure changes from tension to shear.

Another type of butt joint (the T-joint of fig. 10(a)) is generally not a desirable joint design. Such a joint will give satisfactory service only if the parent metal is quite soft (like copper) so that the structure can deform without creating excessive stress at the joint seam. Better choices are illustrated in figs. 10(b) and (c), where the flanges provide higher fatigue resistance against flexing.

Conclusions

To summarize, brazing with silver alloy filler metals is a quick, convenient, clean method for joining any combination of light or medium gauge metals whose melting points are above approximately 1500 deg F. In rather heavy assemblies, where concentrated heat would have to be used to raise the thick sections of metal up to the melting point of the filler metals, other joining methods such as arc welding are preferable. Such applications include assembly and repair of heavy pressure vessels and structural work.

The fluidity and low melting temperatures of these filler metals make it possible to use virtually any standard heating equipment from the simple handtorch to induction and furnace heating.

Because of the low temperatures involved, brazing with silver alloy filler metal can be done in air. Little change is produced in the metallurgical characteristics of the metals joined and problems of later clean-up operations are at a minimum.

No unequivocal data can be given on strength of joints brazed with silver alloy filler metals or any other filler metals. The strength of the filler metal itself is only one factor in the final strength of the joint. Other very important factors include the strength of the materials being joined, distribution and nature of the stresses, the type of joint and other items which involve the strength of the structure as a whole, rather than the layer of filler metal as an isolated entity.★

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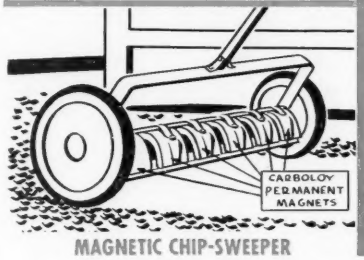

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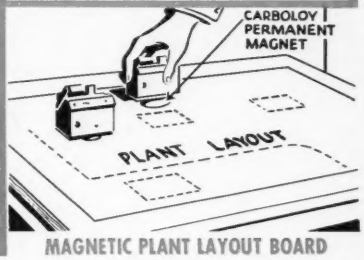

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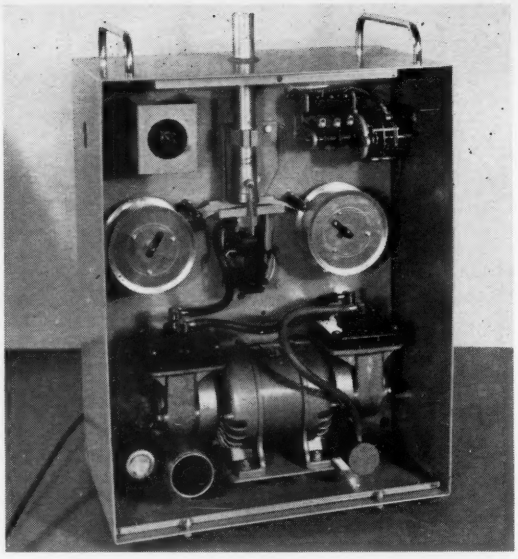
requirements. The instrument, which is housed in a 9 x 18 x 30 in. metal box, is designed to run for long periods unattended, the length of time between visits being gauged by the length of the filter paper roll and the frequency with which samples are taken. Samples may be removed as frequently as desired without interfering with the functioning of the instrument.

Recognizing the importance of this instrument as a tool to meet the requirements of authorities interested in the problem of smog, Mechron Engineering Products of Ottawa have taken the North American distributorship for this device.

The company was founded in 1948 by two young design engineers, Spencer Ballantyne and George Askwith, who started in business by selling and installing diesel-electric machines and designing the associated equipment. Mechron is a coined work, a combination of "mech" from mechanical and "ron" from electronic. Like so many other firms that are now well-established, Ballantyne and Askwith started in a garage.

The Fleming air pollution recorder may be used to sample (for analysis) any foreign element in the air—smoke, industrial gas and chimney discharge, such as from cement or chemical plants.

Although a precision instrument, its price is such that it should have wide application by public health authorities and industry. Already interest has been shown in such widely separated points as the federal Health Department in Ottawa and by public health officials in the southern United States. (215)



Simple layout of the Fleming air pollution recorder.

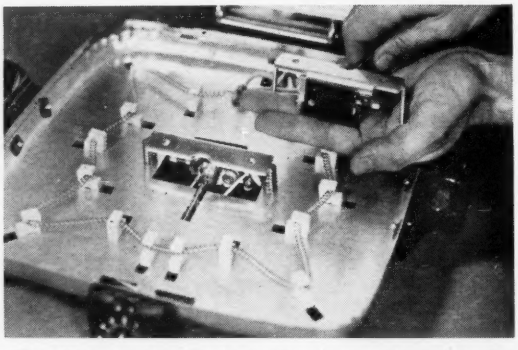
Who says black is more heat-absorbent than white?

Certainly a black surface absorbs more light than a white one, but does it absorb more heat? The answer, given by A. D. Smith (of Westinghouse) at a recent AIEE Conference is: "Not necessarily. It may, in fact, absorb less."

It is the chemical and physical nature of a surface that determines its heat absorption value, not its color. Take frost, for example. Visibly white and a good spectral reflector, it absorbs 98.6% of all incoming radiation in the infrared range for one of the highest heat absorption values known.

A thorough understanding of this factor is extremely useful in the design of electrical appliances. Such otherwise mysterious problems as high table-top temperature, extreme power requirements and inaccurate thermostats are often solved by changing one of the materials subject to heat or (more simply) by coating it with a finish of the proper absorption value. One of the most effective finishes available, according to Smith, is a mica-pigmented coating based on Dow Corning silicone resins. Although almost colorless, it has an absorption rating of 96.5%, the highest of any finish yet tested. Thin and flexible enough to withstand heat expansion and contraction inside an appliance, this silicone based finish retains its physical and absorptive values despite prolonged exposure at temperatures as high as 500 deg F.

Its effectiveness is evident in a waffle baker in which heat-absorbing interior coatings alone reduce the power required from 1,000 to 800 watts and almost halved the preheat and cooking time. Much of the difference in performance was obtained by coating the underside of the aluminum grids with a heat-absorbing cement. The improvement was so drastic, in fact, that the baker's thermostat lagged and over-traveled. The thermostat itself was then coated with the silicone-mica finish and a similarly finished baffle was installed to cut off radiation from the coils.



The silicone-mica finish on the thermostat and baffle.

Radiation, therefore, was picked up only from the grids and by conduction, resulting in a highly sensitive thermostat and a much faster and more economical unit.

Where heat reflectance (rather than absorption) is desired, an aluminum finish based on epoxy resins can be used, simply because reflectance is so high that the surface temperature remains low.

While effective "as is," the silicone finish is best dyed or colored black, for its psychological effect. Customers will associate a black finish with good heat absorption, even if incorrectly. It also eases visual inspection of the parts involved at the factory. (216)

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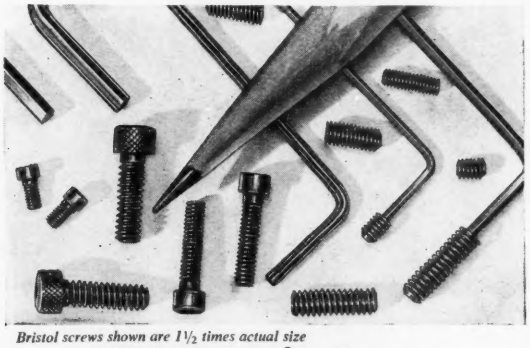

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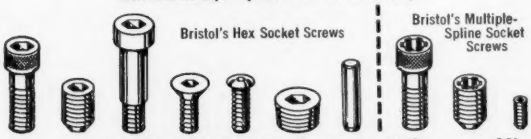

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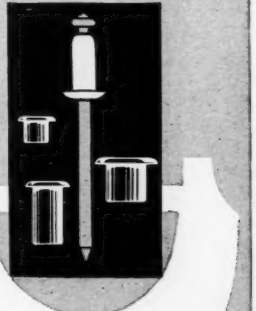

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Modern industrial electronic engineering has been coordinated with electric motor design to provide a versatile means for obtaining the full possible advantage of speed control in DC motors while operated from the regular alternating current power line. Grid controlled "Thyratron" tubes are utilized for power controlled stepless variation to supply motor armature power. Patented feedback, or "Servo" circuits provide constant torque capability over wide speed ranges of as high as 60 to 1 in some models and a minimum of 20 to 1 in others.
Servospeed
DIV. of ELECTRO DEVICES, Inc.
4 Godwin Ave., Paterson, N. J.
ARmory 4-8989

New products & materials

New items which can help you on the job

Gas heating control

A new automatic gas heating control for use with warm air furnaces is the Unitrol Model 400-E.

Modeled from other **Robertshaw-Grayson** controls (used on millions of automatic gas water heaters) it combines a gas cock, thermostatic valve and automatic pilot in a single compact unit. The thermostatic valve operates (on the heat motor principle) on 24 volts ac and can be used with all types of room thermostat.

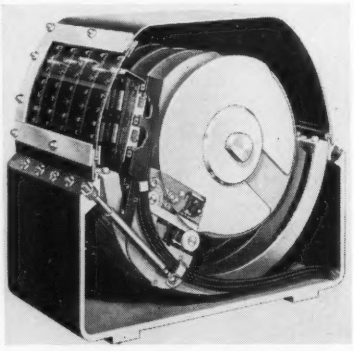
Model 400-E has features which furnace manufacturers have specified they want in one compact unit, the company points out. It has a snap-action gas valve for positive and completely silent performance. The automatic pilot is of the 100% shut-off type.

Other advantages are ease and economy of installation and servicing. (217)

Cam limit switch

A rotating cam limit switch with 15 amp contacts, specially designed to facilitate precise synchronization of multiple operations, has been developed by the **Clark Controller Company.**

The switch features a positive micro-



Adjustments can be made from outside

meter-screw adjustment of each individual switch mechanism in relation to its cam. This adjustment can be made with a screwdriver, from the outside, while the switch is in motion.

This Type AL switch is made in three standard sizes accommodating up to five, nine or twelve cams. The split butterfly cams can be set with a spread between circuit make-and-break of from 15 to 345 deg and the external in-motion adjustment of 15 deg makes possible micro-adjustment while in motion. (221)

Switch assemblies

On occasion, the engineer may require electrical portions of his control system to operate as functions of shaft positions. His design may specify that a circuit be opened and closed at predetermined shaft positions or it may call for make-and-break in a pulse pattern. This is accomplished by the combination of a microswitch unit with either a cam assembly or a pulse disc.

The microswitch made by **Servo Corporation of America** is a single throw, double-pole limit switch. Rated at 10 amps for 24 to 30 volt dc and 0.6 amps at 110 to 125 volt ac, it is mounted on a Servoboard component hanger. Switch terminals permit its use either as a normally closed or a normally open unit.

The cam assembly consists of a pair of cams, used in conjunction with the microswitch unit to open or close a circuit at a specific shaft position. The two anodized aluminum cams are mounted on the shaft. After one cam has been locked to the shaft, the other is set and locked for any dwell period from 0 to 360 deg. The lobe (high part) of the cams is used to set a dwell period greater than 180 deg; the valley is used for shorter periods. The microswitch is accordingly wired to provide the proper action during the dwell period.

The pulse disc is used in conjunction with the microswitch unit to open or close a circuit at a number of specific shaft positions. Regular or irregular pulse patterns may be established to simulate a sequence timer. The desired positions are set by mounting pulse tabs on the disc as indicated.

The pulse disc is provided with 36 tabs and their hardware. Each tab has a pointed and a blunt end and may be mounted either end up for sharp or slightly extended pulses.

The new cylinder is rated 250 psi air, 500 psi water or oil. It is available with all standard interchangeable mounts, in all standard strokes, cushioned or non-cushioned. (218)

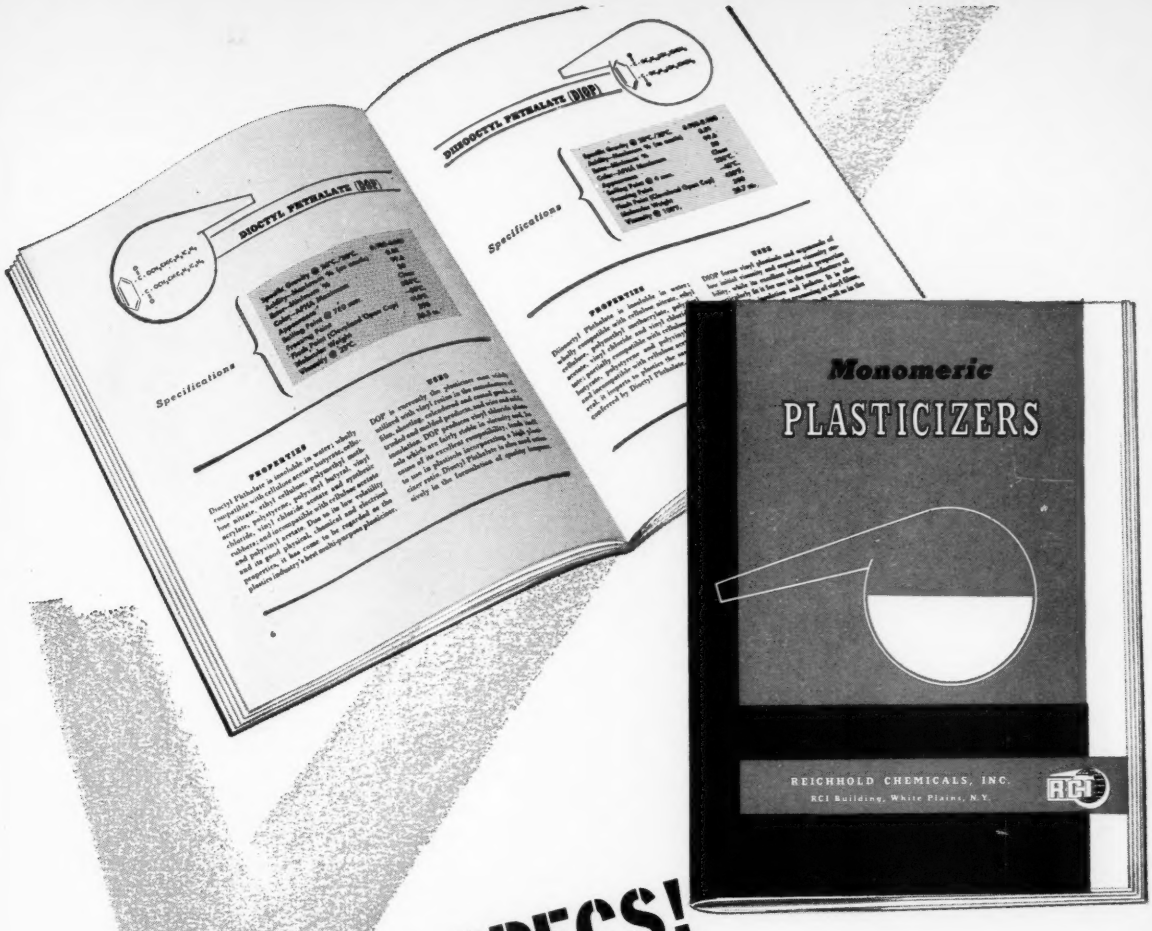
Weight calculator

A handy calculator makes it easy to determine the weight of springs made from given sizes of round wire or flat stock.

The calculator, offered by **National-Standard Company,** is of the circular slide-rule type with one side for round wire and the other for strip.

To calculate the weight of pieces fabri-

(Continued on page 61)



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Didecyl Adipate
Dibutoxyethyl Adipate
Dibutyl Sebacate
Dioctyl Sebacate
Diisooctyl Sebacate
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company indicated on this letterhead. I would like the catalog on monomeric plasticizers to be sent to me by:

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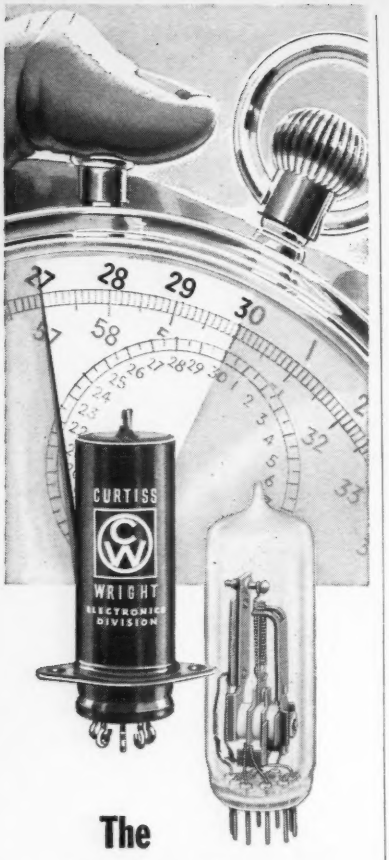

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- Single-pole, double throw contacts
- Wide ambient range (—65°C +100°C)
- For military, commercial and industrial applications
- Metal envelope (7 or 9 pin) miniature or (8 pin) octal
- Glass envelope in 9 pin miniature
- Preset time delays in metal from 3 to 90 seconds, glass from 5 to 60 seconds

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Quotes

Points from current papers and speeches

Shock testing

Until now, shock-testing equipment available to industry has been cumbersome, expensive, and of limited versatility. Programs requiring shock simulation have been geared around air cannons, impact hammers, complex mechanical systems, trial-and-error field tests and drop towers.

Now a new precision instrument, the Hyge actuator, makes it possible to simulate unlimited shock conditions accurately and reliably. Originally developed by Convair engineers, according to **CEC Recordings** for September-October, 1956, this device was used to test advanced aircraft and guided-missile designs with greater precision than had previously been possible.

For the first time, industry has available a compact instrument capable of producing extremely high loads instantaneously, with precision waveform control.

The actuator can develop thrust-loads ranging up to tons, at acceleration values several hundred times g, in times measured in milliseconds. Yet, it is compact in size, versatile and offers little or no installation problem.

It operates on the principle of the rapid release of stored energy. It has only two moving parts: a piston and a floating seal. Complicated controls, or elements like rapid-acting valves or blowout diaphragms, are not used. All units have a rated operating pressure of 2,000 psig and a rated output thrust of 12,000 lb. At present, the standard internal bore diameter is three inches.

Engineering writing

Engineers can improve their technical writing considerably merely by writing in a friendly easy-going style and omitting the pedantic, legalistic jargon that is now found in typical writing of engineers. Engineers use this stilted style of writing because they think that it makes their writing appear learned. Actually it merely annoys the reader. This was told to a class of engineers at the **Western Technical Writing Institute,** Pasadena, California, by John L. Kent, an authority on technical writing improvement.

Part of the reason for this stilted writing is the engineer's desire to show off his knowledge and appear learned. Part is due to his inability to write simply. How to write simply is not taught in colleges.

Underlying the whole problem is the engineers' failure to consider the reader. Considering the reader is the key to readable writing. All professional writers recognize that. But the engineer often writes only for himself. Engineers and other technically trained persons in the audience were advised to plan their writing (by making an outline); consider the reader (write for the typical reader); use short sentences and short words; summarize information (to save readers' time); be critical (read over many times and edit).

New bonding method

A new method of bonding strips of aluminum-tin alloy to steel strips to form bearings has been developed. The new method, details of which are given in the **Quarterly Journal of the Tin Research Institute,** No. 36, is an improvement upon earlier methods, since it makes unnecessary the special operation of aluminizing the steel strip before bonding it with the aluminum-tin alloy.

The aluminum-tin alloy strip is now applied to a strip of bare steel of the same length, the ductilities of the two strips having been first matched as nearly as practicable. The two strips are then welded together by rolling under pressure until the composite strip has been reduced to about half its initial thickness.

The aluminum-tin alloy is produced in a hard state by cold-rolling a ½-in.-thick chill-cast billet down to 0.060-0.100 in. The steel strip must be of a low carbon type of high ductility, in the fully soft condition and should have a bright finish. No surface treatment is given either to the alloy or to the steel, apart from degreasing and scratch-brushing on the surfaces which are to be rolled together.

Bonding may be done at room temperature but stronger bonds are obtained by rolling at elevated temperatures up to 200 deg C. It is not necessary to control the atmosphere of the heating ovens, because fresh surfaces free from oxides are produced by the elongation of the strips during rolling. Excellent bonds have been obtained when the steel has acquired a blue oxide film.

The rolling should produce a reduction of from 40 to 65% in a single pass. In spite of the initial matching of ductilities, the aluminum-tin alloy suffers a slightly greater reduction than the steel. The strength of the bond developed is approximately proportional to the reduction in thickness. Adhesion of the strips is slightly improved by annealing for one hour at 360 deg C. The control of thick-

ness of the alloy and the backing steel in the finished strip is achieved to an accuracy of about one hundredth of an inch by selecting suitable initial thicknesses for the alloy and the steel strips. Finished bearings have been made at the Institute having alloy thicknesses ranging from 0.020 to 0.043 in. and steel backings of 0.035 to 0.150 in.

Gear fatigue

Endurance testing of spur gears in modified four-square gear testing machines, also referred to as special gear testing dynamometers, power circulating gear testing machines or single-pair gear test machines, was dealt with in an SAE lecture by **John A. Halgren** and **D. J. Wulpi.**

In machines of this type, the test torque is locked within a closed system (Hopkinson coupling), so that the only external power required to run the machines is that which is necessary to overcome static and dynamic friction. The ability to impart high loads to the test gears with only a small driving force, and without external power absorbing equipment, constitutes the principal advantage of modified four-square gear testing machines over dynamometer equipment for testing gears. Initial costs, operating costs and maintenance costs favor the modified four-square gear testing machine.

Since the gears are mounted in special gearboxes, modified four-square gear testing is sometimes referred to as testing under an ideal or simulated environment. With the same line of reasoning, gear testing in opposed transmission rigs, in chassis dynamometers and on laboratory dynamometers is considered to be testing under a normal environment. This differentiation is neither realistic nor fair to any of these test methods, since it pertains only to the gear mounting design and neglects such equally important factors as the mass-elastic system of the complete testing unit.

Much of the confusion concerning the relative merits of gear testing methods undoubtedly results from the dual definition of the word gear. In one usage a gear signifies a toothed wheel or cogwheel. In another, a gear designates a train of mechanisms, including bearings, shafts, cogwheels, gearbox and so forth.

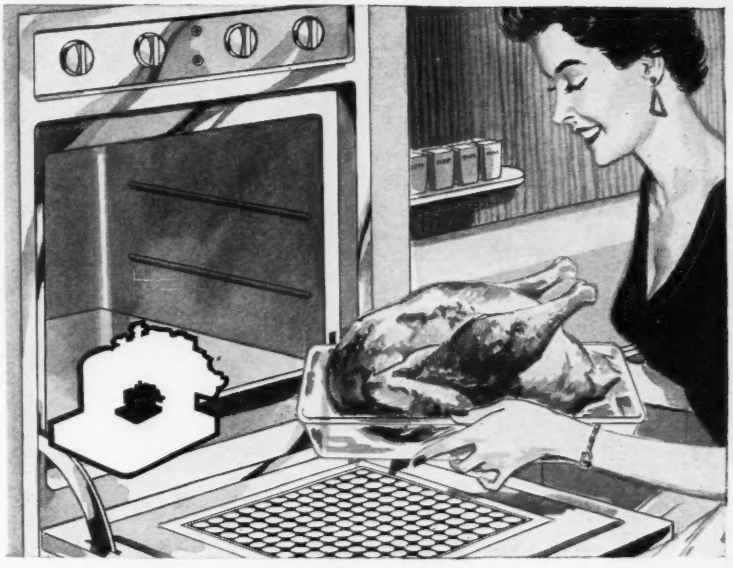
KWIZ KORNER

Do you know what these are?

1. Ytterbium
2(a). Arithmetic mean
2(b). Geometric mean
2(c). Logarithmic mean
3(a). SAHIB
3(b). SARAH

Answers given on page 60

Potter & Brumfield *engineering is in this picture*



Which P&B relay would you specify to

CONTROL AN ELECTRONIC OVEN?

PR Series

MS Series

MR Series

New electronic ovens—the kind that cook an 18-pound turkey to delicious perfection in an hour and a half, and bake potatoes in an amazing 4 minutes—require heavy duty, fast-acting relays designed for high voltage switching. Long, trouble-free service is essential and U/L approval is a must.

P&B's PR 11 relay—easily and economically adapted to this customer's specifications—exactly filled the bill. P&B engineers are old hands at adapting basic relay types to highly specialized uses. Twenty-five busy years of relay designing, engineering and manufacturing at P&B have built an unrivaled backlog of information and skill which is yours to command.

ENGINEERING DATA

SERIES: PR Heavy Duty.
CONTACTS: Max. DPDT. 5/16" dia. silver, 13 amps at 115 V., 60 cycle, non-inductive. 6.5 amps at 230 V., 60 cycle, non-inductive.
VOLTAGE RANGE: 6 to 110 V. DC. 6 to 230 V. AC.
COIL RESISTANCE: 63800 ohm max. DC.
TEMPERATURE RANGE: DC, —45° to 85° C. AC, —45° to 55° C.
PULL-IN: DC, 75% nominal. AC, 78% nominal.
TERMINALS: Heavy duty screw type. Adaptable for printed circuits or plug-in.
BASE: Molded phenolic or metal.
MOUNTING: (2) 3/16" dia. holes on 1⅞" centers.
DIMENSIONS: 2½" W. x 3⅜" L. x 2½" H.

P&B Representatives in Canada: Aeromotive Engineering Products, Montreal
A.T.R. Armstrong, Ltd., Toronto • Charles L. Thompson, Ltd., North Vancouver

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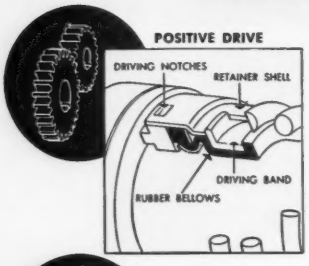
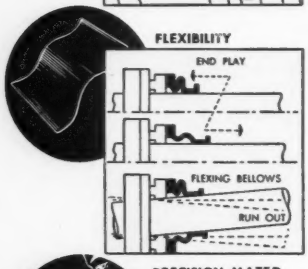
Subsidiary of AMERICAN MACHINE & FOUNDRY COMPANY
Manufacturing Divisions also in Franklin, Kentucky and Laconia, New Hampshire

JOHN CRANE Shaft Seal Design With A Purpose!



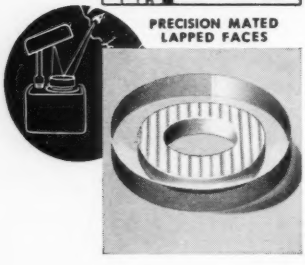
POSITIVE DRIVE

This gives long seal life. Drive is transmitted through the driving band and washer driving notch which absorb all breakout and running torque. Damaging stresses on the bellows or flexible sealing member are eliminated. Slippage is also eliminated, thus protecting shaft or sleeve against galling.



FLEXIBILITY

Axial and radial misalignment problems are eliminated. Self-adjusting bellows or sealing head automatically compensates for shaft end play or run out. Minimum spring pressure is required for axial shaft movement and uniform spring pressure is maintained during radial shaft movement.



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A SEAL FOR EVERY SERVICE

All "John Crane" Seals are constructed to the particular service requirements . . . from hot or cold water to the most destructive acids, corrosives and gases . . . temperatures up to 1000°F. . . . pressures to 1200 psi. They can be furnished in types and sizes to meet practically any mechanical or dimensional condition.

Request Bulletin S-204-2. Containing full information on "John Crane" engineered shaft seals.

GET COMPLETE DETAILS

Crane Packing Co., Ltd., 631 Parkdale Ave. N., Hamilton, Ontario

CRANE PACKING COMPANY

Flexible hose

(Continued from page 28)

comparison with rubber, plastics, composite or, indeed, seamless metallic hose.

The two metals most commonly used are bronze and electro-galvanized steel and most of the commonly used liquids can be conveyed through hoses made of these metals, without deterioration to the liquid or the inner surface of the hose. Naturally, of course, there are many acids and chemicals that would be unsuitable, either because they would damage the tubing itself or because they would be contaminated while passing through the metal hose. Stainless steel hose does deal effectively with some of the more active or corrosive liquids, but it has to be ruled out in many cases because of its higher cost, due to the expensive processing of the raw product and the more difficult and costly operation of forming it into hose.

Metallic hoses are manufactured to operate statically (once fitted) and under occasional or frequent flexing conditions. Where high pressures are experienced, an external wire braiding is usually applied.

Typical applications for this type of flexible include steam pressure and vacuum applications and for conveying air, gases, oils, water, chemicals, bitumen and machine tool coolants.

Plastics flexibles have been developed satisfactorily only in recent years and offset many characteristics not common to rubber or metallic hoses. On the credit side: light weight, exceptional weathering qualities and the fact that with transparent types the cycle of operation in the free flow can be observed through the hose. Plastics flexible are also inert to many widely used oils, acids and chemicals.

Among the disadvantages must be mentioned a susceptibility to heat. All types of plastics hose are heat-formed, so that operating temperatures should never approach or exceed the temperature at which the hose was originally manufactured. Working temperatures should not usually exceed 75 deg C. A possible danger is cold flow, which can take place (often at the end fitting points) and cause loosening. There is also a tendency toward stiffening under low temperature conditions.

Although the resistance of plastics hoses to acids and chemicals is much greater than with either rubber or metal, careful consideration must be given to the conditions of application before using such flexibles.

Other types of plastics flexibles include reinforced hoses, which are ideal for short fuel lines, and commercial and nontoxic varieties which can be used with fuel oil, air, water, gas and food.

(Continued on page 59)

Flexible hose

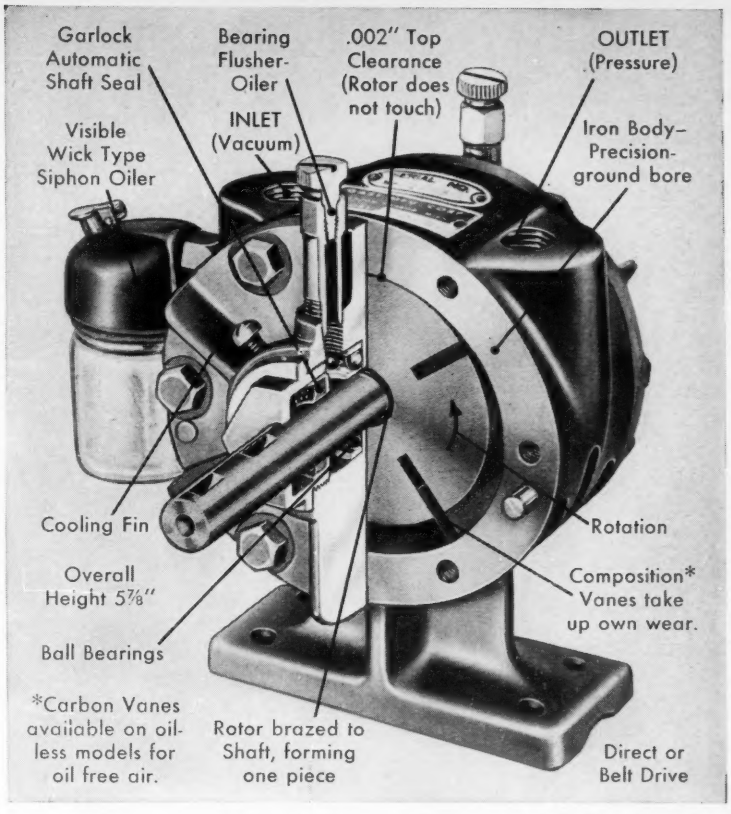
(Continued from page 58)

Composite flexibles. These were really developed during the war when the shortage of such raw materials as rubber called for improvisation and a search for substitutes. The basis of a composite hose is simply one or more wire helices, and it is possible to incorporate in such a hose a wide variety of materials. After a thorough examination of the conditions under which such a hose would have to operate, and an equally thorough study of all the known materials from which it could be made, it is now possible to combine almost any known woven, pressed or formed sheet material which has the slightest pliability. The range of these materials is almost infinite and it is therefore impossible to give more than a brief indication of their qualities. They include canvas, cambric, asbestos, terylene, nylon and wood fibre, which can be used in all weaves, strengths or weights, either in their natural form or processed by impregnation or coating with any synthetics, natural rubber or plastics which flow under heat or pressure.

Where crush resistance or a constant bore is necessary, the introduction of a spiral wire, either completely embedded or exposed as an armoring, not only achieves its purpose adequately, but may become an integral part of the hose, thus allowing maximum flexibility with lightness and strength.

In the actual production of composite hoses, plies of treated, coated, or impregnated fabric material, sometimes interleaved with synthetics in sheet form, are wound on mandrels in succeeding layers. These can be few or many, according to the design planned by the development department, after analysing and catering for the specific working conditions. In rough bore hoses, these plies are wound over an inner supporting wire spiral; in smooth bore hoses, the spiral can be either completely embedded or surface embedded into the plies. A final outer holding and armoring wire is then applied. For particular requirements the whole hose can be heat cured, so bonding the various wall plies together. Where the materials do not require curing (or do not lend themselves to it), the outer wire can hold the plies over the inner wire to form a perfect, highly flexible and fluid-tight hose.

Most composite flexibles can be supplied with a rough bore or a smooth one. Generally, there is a great deal of nonsense talked about the advantages of smooth over rough bores, but as a result of experience it is reasonable to suggest that a smooth bore is of importance only when the least resistance to flow is essential or where the chemicals being carried would attack the wire reinforcement in the inside of the hose. ★


Garlock Automatic Shaft Seal
Bearing Flusher-Oiler
.002" Top Clearance (Rotor does not touch)
OUTLET (Pressure)
INLET (Vacuum)
Visible Wick Type Siphon Oiler
Iron Body–Precision-ground bore
Cooling Fin
Rotation
Overall Height 5⅞"
Composition* Vanes take up own wear.
Ball Bearings
*Carbon Vanes available on oil-less models for oil free air.
Rotor brazed to Shaft, forming one piece
Direct or Belt Drive

rotary vane

Quality and simplicity keep

GAST AIR PUMPS

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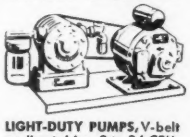
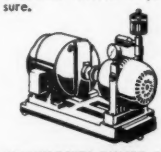
INTEGRAL-MOTOR PUMPS 1/12 to 1/3 H.P. .6 to 4 CFM. to 28" VAC., to 25 PSI.



LIGHT-DUTY PUMPS, V-belt or direct drive. 2 to 24 CFM. Moderate vacuum or pressure.



HEAVY-DUTY PUMPS, 1/4 to 1-1/2 H.P. 4 to 21 CFM. To 28" VAC. or 30 PSI. Cooling fans and fins.

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Ⓑ **NYLOK® FASTENERS** stop weeping bolts, dripping oil pans, gasoline, alcohol, and air leaks. Won't vibrate loose, shrink, dry, or turn brittle. Unaffected by age, or sustained temperatures up to 250°F.

Ⓑ **NYLOK'S®** are easy to take-up or back-off. Stay locked at ANY depth . . . need not be fully seated. Give smooth torque with no damage to threads or seating surfaces.

THE SECRET . . . a permanent insert of tough, resilient nylon with positive LOCKING and SEALING properties easily adapted to any Ⓑ threaded fastener.

ELIMINATES costly locking devices and double inventory. Saves handling and assembly time.

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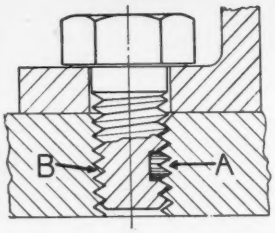
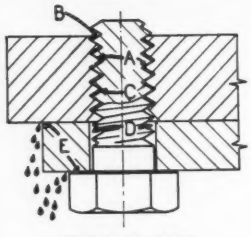
HOW NYLOK WORKS



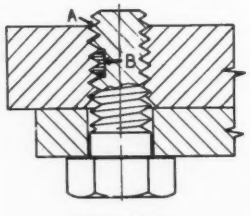
● Resilient nylon pellet (A) sets up lateral thrust which wedges mating threads smoothly together (B). All locking action is on the threads. Tight, metal-to-metal union . . . positive, leak-proof lock.

HOW NYLOK SEALS



STANDARD BOLT

● Axial force causes load-bearing faces to meet tightly at (A). Fluid is prevented from following helical path down to flange, or bolt head. Nothing, however, prevents fluid entering above non-load-bearing faces (B) from following helical path (C) to clearance hole (D) and seeping out at (E).



NYLOK BOLT

● With NYLOK® seal, both load and non-load-bearing faces meet in tight metal-to-metal union. Fluid entering at (A) flows only as far as NYLOK pellet (B) which provides effective dam to further flow . . . puts an end to leakage.

SELF-LOCKING SELF-SEALING Ⓑ **NYLOK® FASTENERS**

Synthetic Sapphire

(Continued from page 24)

Bearings. Manufacture was greatly simplified when Linde succeeded in growing the crystals in long-rod form. Originally, the tiny bearing blanks had to be carefully cut from boules by a succession of slicing and grinding operations. Now, the bearing blanks are simply sliced off the rod ends.

Balls. A centreless grinding technique was developed to make sapphire balls that range from a few hundredths of an inch to over ½ in. diameter. The smaller ones are used in ball-point pen manufacture, the larger sizes are check valves and rotameter floats.

Polishing Powders. In fine powder form, sapphire is used to obtain extremely smooth, scratch-free surfaces on materials ranging from metallographic specimens to gem-stones and noble metals. They are fine particles of aluminum oxide of exceptionally uniform size. ★

Answers to KWIZ KORNER

(Questions are on page 57)

1. **Ytterbium.** One of the rare earth series of metals, symbol Yb with an atomic number of 70 and an atomic weight of 173.04. It is obtained from mineral sources in Sweden.

2(a). **Arithmetic mean.** For two quantities a and b, the arithmetic mean is the ratio $\frac{1}{2}(a+b)$

2(b). **Geometric mean.** For two quantities a and b, the geometric mean is the value $\sqrt{ab}$. It may also be considered as the mean proportional between a and b.

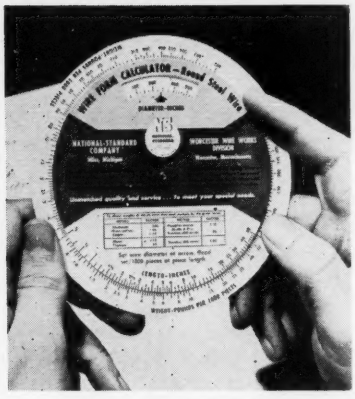
2(c). **Logarithmic mean.** For two quantities a and b, the logarithmic mean is given by $\frac{(a-b)}{\log_e a/b}$

3(a). **SAHIB.** This is a useful mnemonic for remembering the formula for shear stress. Taking S as the shear load applied to the section of a beam having a cross-sectional area A and calling the distance of the centroid from the neutral axis of the beam H, then the shear stress τ is given by the expression: $\tau = SAH/IB$, where B is the width of the beam and I its moment of inertia.

3(b). **SARAH.** Abbreviation for "Search and Rescue and Homing," a device designed to take the guesswork out of search-and-rescue. It is essentially a tiny transmitter or beacon carried by survivors whose signals can be picked up by special receiving and homing equipment in a rescue craft.

New Products

(continued)



Spring weight calculator

cated from round wire, the rotating disc is set on the diameter scale, which ranges from 0.005 to 0.250 in., and the weight (lb per thousand pieces) is read opposite the lengths of the wire. Length is given on a scale ranging from ½ to 50 in.

To determine the weight of pieces fabricated from strip, the width of the piece, marked on a scale on the rotating disc, is set opposite the thickness. Weight (lb per thousand pieces) is read on the outside scale opposite the length, which is also indicated on the rotating disc. Weight of strip ranging from 1/16 to 25 in. wide, 0.001 to 0.300 in. thick and ½ to 100 in. long can be calculated on the device.

Scales are designed for steel and conversion factors given for aluminum, brass, copper, monel, titanium, phosphor bronze and stainless steel. (219)

Water tube boiler

Some two years ago, **Dominion Bridge Company Ltd.** introduced a fire tube package unit using as the main component the Scotch dry back boiler. They now announce a water tube package unit type which is available in seven standard sizes ranging from 10,000 to 30,000 pph. Several of the boilers are already operating satisfactorily under actual service conditions, as witness the typical boiler of this type installed at Silverwood Dairies in Winnipeg. Space was limited in this case and the compact unit was practically "shoe-horned" into the space available.

The newly developed line of boilers is of the oil gas pressure fired type and is available for standard design pressures of 200 to 250 psi. No induced draught equipment or high stack is required. Higher pressures and capacities can be provided to special design and superheat is available on larger sizes. (220)

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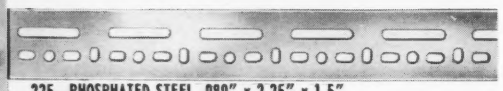

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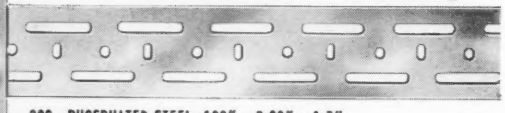

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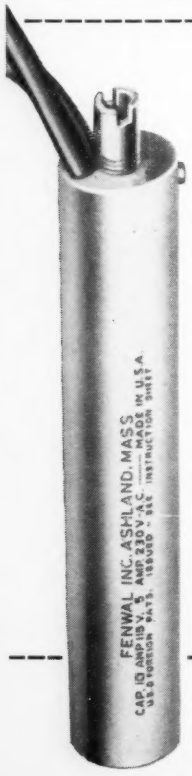

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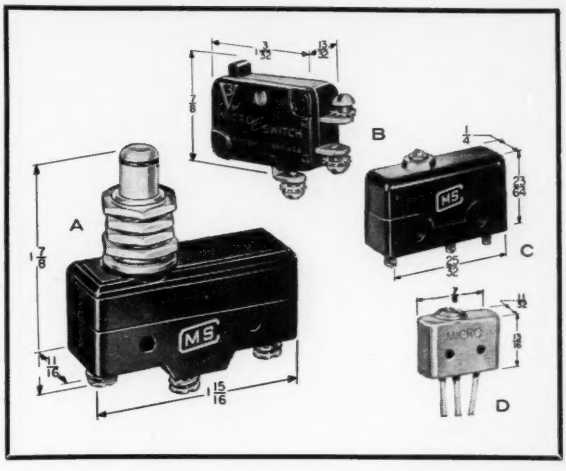

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Editorial

Research must originate in Canada

In the short space of a few months, two significant events have taken place in Canada. A few months ago the electronics division of Canadian Westinghouse opened its new environmental laboratory at Hamilton for the purpose of carrying out shock and impact tests, vibration tests on missiles and tests under high altitude conditions in the Tenney stratosphere chamber. More recently, at Peterborough, Ontario, Canadian General Electric opened a new laboratory for research and advanced engineering.

The importance of original research work in Canada has long been recognized in some quarters, of course. For some time, in fact, Avro Aircraft have been operating a research and development laboratory for carrying out tests to reduce the risk of failure of aircraft parts, both in flight and on the ground. Included are investigations of new alloys by metallurgists and structural tests that simulate the loads, vibration and temperature of actual flight.

Then again, there is the Sopwith Laboratory at Orenda Engines, where tests are made on torsion, creep, fuel-systems, instruments and, in a sound-proof rig room, engine bearings, gear boxes and generators.

Only a week or so ago it came to our notice that the Sperry Gyroscope company of Canada had received a development engineering contract from a U. S. firm to redesign and re-package an existing air-borne radar indicator. It is indeed a sign of the times that the know-how of a Canadian company should be sought in this way from outside!

The whole question of research in Canada was summed up very well by CGE's president, James Goss, in his recent speech to the Electric Club of Toronto. He stated that we are now at the stage where we can do (and are doing) much for ourselves: we are no longer dependent on importing technical knowledge. Our products are emerging, not just as pieces of equipment following closely the teachings of the U. S. or the U. K., but as really new and worthwhile Canadian engineering achievements.

In these days of world unrest it is imperative, in the interests of national safety, that our engineering design and research should be as self-contained as possible. The setting up of these research laboratories is a step in the right direction, because it means that we can do an increasing amount of original work and produce an increasing number of original Canadian product designs.

It is, in short, an indication of the coming of age of Canadian engineering.

William Morse.

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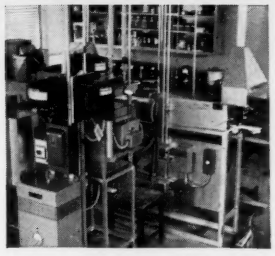
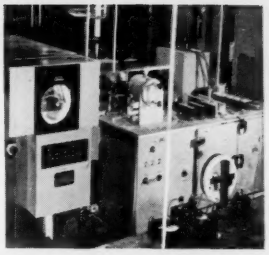


High temperature globar furnace; muffle furnace for enamel testing; hydrogen atmosphere sintering furnace.



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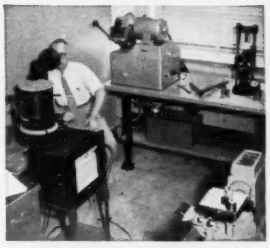

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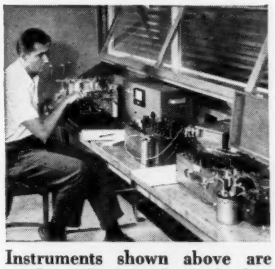
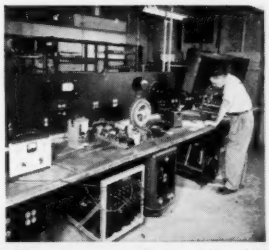


Instruments shown above are used to check and standardize the many pieces of Ohmite electrical test equipment.



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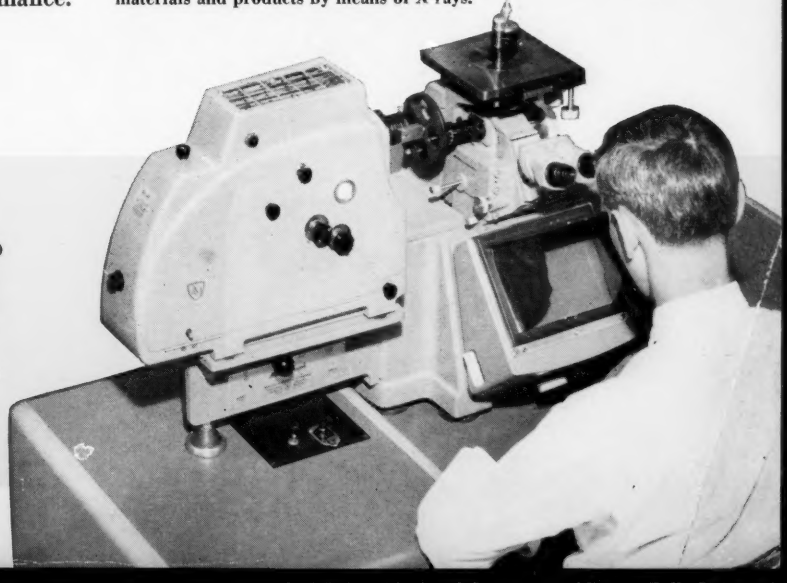

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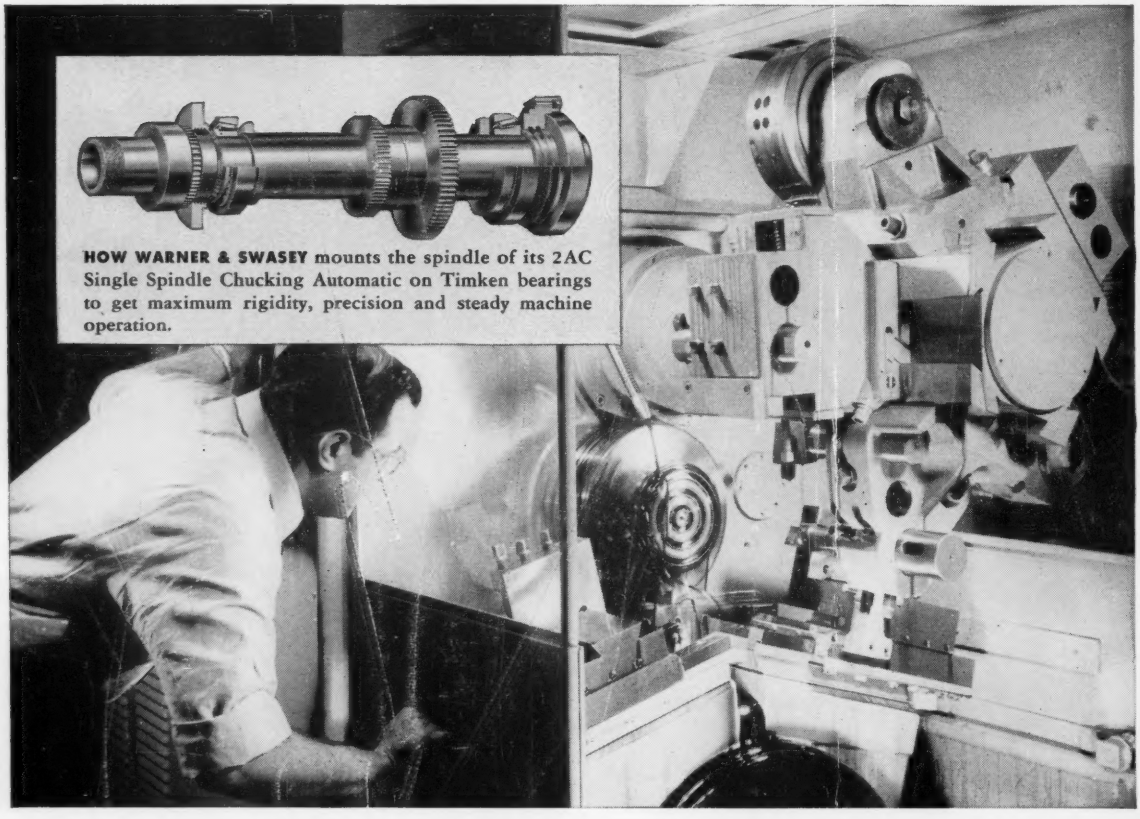
Timken bearings also save power because they practically eliminate friction. They are geometrically designed to give true rolling motion, precision manufactured to live up to their design. And to be sure we get steel good enough for Timken bearings, we make our *own* fine alloy steel.

No other bearings give you all the advantages that Timken bearings give you. That's why so many manufacturers of equipment that *must* have dependable bearing performance use them. Whether you buy or build machinery, be sure to specify Timken bearings. Look for the trade-mark "Timken" on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. **CANADIAN PLANT:** St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



HOW WARNER & SWASEY mounts the spindle of its 2AC Single Spindle Chucking Automatic on Timken bearings to get maximum rigidity, precision and steady machine operation.

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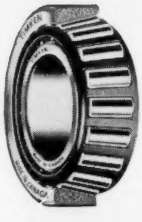

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